CONICAL SCANNING MICROWAVE IMAGER/SOUNDER (CMIS)

Sensor Requirements Document (SRD)

for

NATIONAL POLAR-ORBITING OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM (NPOESS) SPACECRAFT AND SENSORS

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1. SCOPE

1.1 IDENTIFICATION

This Sensor Requirements Document sets forth the requirements of the CONICAL SCANNING MICROWAVE IMAGER/SOUNDER which is part of the National Polar-orbiting Operational Environmental Satellite System (NPOESS) and is hereinafter referred to as the CMIS.

1.2 SENSOR OVERVIEW

The purpose of the CMIS is to collect global microwave radiometry and sounding data. This data will be processed to produce microwave imagery and other specialized meteorological and oceanographic data using algorithms developed in conjunction with the flight hardware. The data will be processed from Raw Data Records (RDRs) into Sensor Data Records (SDRs), Temperature Data Records (TDRs) and Environmental Data Records (EDRs). Data will be disseminated to users worldwide by the Department of Defense, Department of Commerce and the European Meteorological Organization.

1.3 DOCUMENT OVERVIEW

This document contains all performance requirements for the CMIS sensor suite. The contractor should use this document as the basis of a proposed sensor suite specification. The documentation listed in Section 2.0 follows an approach of minimum specifications and standards. The contractor may add to or revise the documents listed in Section 2.0 in coordination with the government. Section 3, Sensor Requirements, provides the detailed requires for the CMIS sensor suite. This section includes the CMIS performance characteristics, design and construction, and related specifications.

The term "(**TBD**)" applied to a missing requirement means that the contractor should determine the missing requirement in coordination with the government. The term "(**TBS**)" means that the government will supply the missing information in the course of the contract. The term "(**TBR**)" means that the requirement is subject to review for appropriateness by the contractor or the government. The government may change "(**TBR**)" requirements in the course of the contract.

Section 4, Quality Assurance and Testing Provisions, provides for the testing, verification and quality assurance for the CMIS sensor suite. Of particular note in this section is the Verification Cross Reference (Section 4.3) and the related matrix (Appendix H). Section 5, Preparation and Delivery, covers preservation, packaging and marking for the CMIS sensor suite. Appendix A contains a definition of the terms used throughout the document. Appendix B, NPOESS Survivability Requirements, is classified and will be made available after contract award. Appendix C provides characteristics of the SDRs, and is presently (TBR). Appendix D contains the NPOESS EDR requirements. Appendix E contains the RDRs and EDRs required for each Central and Field Terminal (TBR). Appendix F defines the acronyms and abbreviations used throughout the document. Appendix G describes Potential Pre-planned Product Improvements. Appendix H is the Verification Cross Reference Matrix (**TBD**).

1.3.1 Conflicts

SRDC1.3.1-1
In the event of conflict between any referenced documents and the contents of this specification, the contents of this specification shall be the superseding requirements.

SRDC1.3.1-2
In the event of a conflict involving the external interface requirements, or in the event of any other unresolved conflict, the contracting officer shall determine the order of precedence.

1.3.2 Requirement Weighting Factors

The requirements stated in this specification are not of equal importance or weight. The following three paragraphs define the weighting factors incorporated in this specification.

a. ***Shall*** designates the most important weighting level; that is, mandatory. Any deviations from these contractually imposed mandatory requirements require the approval of the contracting officer.

b. **S*hould*** designates requirements requested by the government and are not mandatory. Unless required by other contract provisions, noncompliance with the *should* requirements does not require approval of the contracting officer.

d. ***Will*** designates the lowest weighting level. These *will* requirements designate the intent of the government and are often stated as examples of acceptable designs, items and practices. Unless required by other contract provisions, noncompliance with the *will* requirements does not require approval of the contracting officer and does not require documented technical substantiation.

1.4 SYSTEM CLASSIFICATIONS N/A

2. APPLICABLE DOCUMENTS

2.1 GOVERNMENT DOCUMENTS

The following documents of the exact issue shown form a part of this SRD to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, see Section 1.3.1. Tailoring of documents in this section is (TBR).

SPECIFICATIONS:

Military

DOD-E-83578A May 96	General Specification for Explosive Ordnance for Space Vehicles,
Mil-A-83577B Feb 88	Moving Mechanical Assemblies for Space Launch Vehicles

STANDARDS:

Federal

FED-STD-209E Sep 92	Airborne Particulate Cleanliness Classes in Cleanrooms and Clean Zones

Military

MIL-STD-461D Jan 93	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference
MIL-STD-462D Jan 93	Measurement of Electromagnetic Interference Characteristics
MIL-STD-1540C Sep 94	Test Requirements for Launch, Upper Stage, and Space Vehicles
MIL-STD-1541A Dec 87	Electromagnetic Compatibility Requirements for Space Systems
MIL-STD-1553B Jan 96	Digital Time Division Command/Response Multiplex Data Bus
MIL-STD-1773B May 88	Fiber Optics Mechanization of an Aircraft Internal Time Division Command/Response Multiplex Data Bus

Department of Commerce/NOAA: None (TBR)

OTHER PUBLICATIONS:

Regulations

AFM 91-201 7 Oct 94	Explosive Safety Standards
EWR 127-1 31 Mar 95	Eastern and Western Range Safety Requirements

Handbooks: None (TBR)

Bulletins: None (TBR)

Other

GPS ICD 200 REV C, 19 January 1995	"NAVSTAR GPS Space Segment/Navigation User Interface"(U) UNCLASSIFIED
GPS ICD 203, REV B 22 Dec 1993	"NAVSTAR GPS SA/AS Requirements(U)-SECRET

(Contractors requiring copies of specifications, standards, handbooks, drawings, and publications in connection with specified acquisition functions should obtain them from the contracting activity or as directed by the contracting officer.)

2.2 NONGOVERNMENT DOCUMENTS

The following documents of the exact issue shown form a part of this SRD to the Extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, see Section 1.3.1.

SPECIFICATIONS: None (TBR)

STANDARDS:

CCSDS 203.0-B-1 Jan 87	CCSDS Recommendations for Space Data System Standards. Telecommand, Part 3: Data Management Service, Architectural Definition, Issue 1
CCSDS 701.0-B-2 Dec 87	CCSDS Recommendations for Advanced Orbiting Systems, Networks and Data Links, Architectural Specification
National Aerospace Standard (NAS) 411 Rev 2, 29 Apr 94	Hazardous Materials Management Program

DRAWINGS: None (TBR)

OTHER PUBLICATIONS: None (TBR)

2.3 REFERENCE DOCUMENTS

The following documents are for reference only and do not form a part of this specification. They are listed here because various parts of the SRD refer to them.

SPECIFICATIONS:

Military: None (TBR)

STANDARDS:

DOD 5200.28-STD Mar 88	Department of Defense Trusted Computer System Evaluation Criteria
MIL-STD-129M 1 Jun 93	Marking for Shipment and Storage Notice 1, 15 Sep 89

MIL-STD 961D Aug 95	DoD Standard Practice for Defense Specifications, w/ Notice 1
MIL-STD-498 5 Dec 94	Software Development and Documentation
MIL-STD-882c Jan 93	System Safety Program Requirements
MIL-STD-1246C Apr 94	Military Standard Product Cleanliness Levels and Contamination Control Program
MIL-STD-1522A May 84	Standard General requirements for Safe Design and Operation of Pressurized Missile and Space Systems
MIL-STD-1542B Nov 91	Electromagnetic Compatibility (EMC) and Grounding Requirements for Space Systems Facilities
MIL-STD-1543B Oct 88	Reliability Program Requirements for Space and Launch Vehicles
MIL-STD-1547A Dec 92	Parts and Materials Program for Space and Launch Vehicles
MIL-STD-1809 Feb 91	(USAF) Space Environments for USAF Space Vehicles
TM-86-01	Technical Manual Contract Requirements

Department of Commerce

DOC Sep 95 Edition Sep 95	National Telecommunications and Information Administration, Manual of Regulations for Federal Radio Frequency Management

NOAA

S24.801 2 Dec 88	Preparation of Operations and Maintenance Manuals
S24.806 30 Apr 87	Software Development, Maintenance, and User Documentation
S24.809 Dec 89	Grounding Standards

NASA

PPL-21 March 1995	Preferred Parts List, Goddard Space Flight Center (Updated May 1996)
SP-R-0 022A (JSC) 9 Sep 74	General Specification, Vacuum Stability Requirements of Polymeric Material for Spacecraft Application
NASA Tech Memo 100471	Orbital Debris Environments for Spacecraft Designed to Operate in Low Earth Orbit
SP 8031 1969	NASA Space Vehicle Design Criteria/Structures

OTHER PUBLICATIONS:

Regulations: None (TBR)

Handbooks

DOD-HDBK-263B (date)	Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies, Equipment
MIL-HDBK-340 1 Jul 85	Application Guidelines for MIL-STD-1540B
DOD-W-83575 Jun 96	Gen Spec for Wiring Harness, Space Vehicle, Design and Testing
MIL-I-46058	Insulating Compound. Electrical (for Coating Printed Circuit Assemblies)
1985	Handbook of Geophysics and Space Environments
AFM 15-111 1 Sep 96	Surface Weather Observations

Bulletins

Other

TRD for NPOESS (current version)	Technical Requirements Document (TRD) for National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Spacecraft Payloads
IRD for NPOESS (current version)	Interface Requirements Document (IRD) for National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Spacecraft
IORD for NPOESS 28 Mar 96	Integrated Operational Requirements Document (IORD) for National Polar Orbiting Operational Environmental Satellite System (NPOESS) Spacecraft Payloads
ASTME-595-93 (current version)	Standard Test method for Total Mass Loss and Collected Volatile Condensable Materials for Outgassing in a Vacuum Environment
Attachment C S-480-80 Revised December 1994	AMSU-A Instrument Performance and Operation Specification (for the EOS/METSAT Integrated Programs); NASA GSFC
SYS/AMS/J0105/BAE 03 Feb 1993	AMSU-B Instrument System Specification (British Aerospace)

(Technical society and technical association specifications and standards are generally available from reference libraries. They are also available in technical groups and using federal agencies. Contact the contracting officer regarding any referenced document not readily available from other sources.)

3. SENSOR REQUIREMENTS

3.1 DEFINITION

3.1.1 Sensor Description

The Conical Scanning Microwave Imager/Sounder (CMIS) will be part of the NPOESS System. It will consist of all ground and spaceborne hardware and software necessary to perform calibrated, microwave radiometric measurements from space, and the software and science algorithms necessary to process on the ground these measurements into a format consistent with the requirements of the assigned Environmental Data Records (EDRs).
Identified below are the Primary and Secondary EDRs assigned to CMIS.

PRIMARY EDRs

Atmospheric Vertical Moisture Profile
Atmospheric Vertical Temperature Profile
Imagery
Sea Surface Winds (Speed and Direction)
Soil Moisture **-** surface (cloudy)
Sea Surface Temperature
Precipitable Water
Precipitation (Type/Rate)
Pressure Profile (surface/profile)
Total Water Content
Cloud Base Height
Cloud Ice Water Path
Cloud Liquid Water
Snow Cover/Depth (cloudy)
Fresh Water Ice Edge Motion (cloudy)
Ice Surface Temperature (cloudy)
Sea Ice Age and Sea Ice Edge Motion (cloudy)
Surface Wind Stress
Land Surface Temperature
Vegetation/Surface Type

SECONDARY EDRs

(**TBS**)

The requirements for each of the above EDRs are discussed in Paragraph 3.2.1.1.1.1. Please note that for some of the EDRs listed in Paragraph 3.2.1.1.1.1 the Threshold and/or Objective values are different from the values specified in Appendix D of this document and Appendix D of the TRD; where changes have been made, the requirements of Paragraph 3.2.1.1.1.1 take precedence.

3.1.2 System Segments N/A

3.1.3 Specification Tree

The specification tree for the System is shown in Figure 3.1.3.

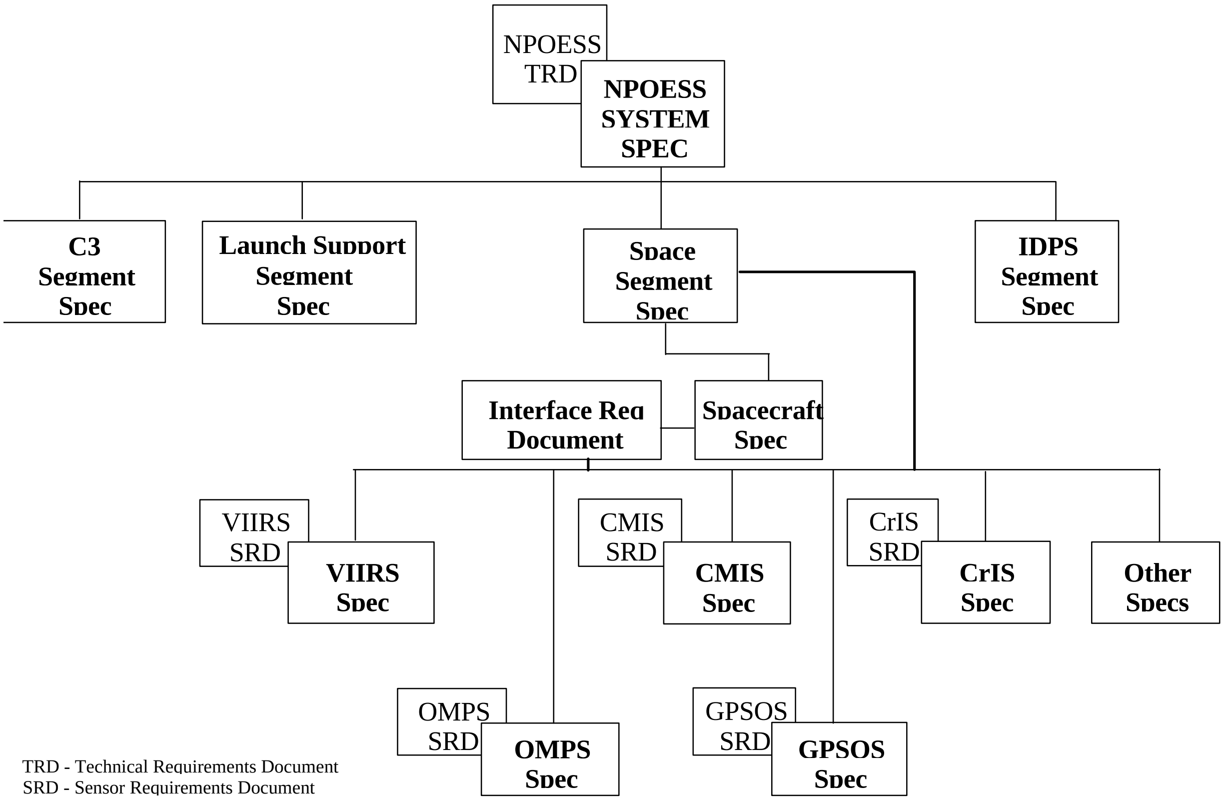


Figure 3.1.3 Specification Tree.

3.1.4 Top-Level Functions

3.1.4.1 Top-Level Sensor Functions

The top-level functions which the CMIS instrument will perform include the following:

- Measurement of scene brightness temperatures,
- On-orbit calibration,
- Preparation and transmission of RDR data to the spacecraft,
- Reporting instrument health and status,

Reception and appropriate response to command and control data.

3.1.4.2 Top Level Algorithm Functions

SRDC3.1.4.2-1
Science algorithms shall process CMIS data, and other data as required, to provide the Environmental Data Records assigned to CMIS.

3.1.5 Sensor Modes

3.1.5.1 Sensor Off Mode

SRDC3.1.5.1-1
In the Sensor Off mode, no power shall be supplied to the sensor.

3.1.5.2 Sensor Operations Mode

SRDC3.1.5.2-1
The sensor shall be in full functional configuration during this mode.

SRDC3.1.5.2-2
Mission and housekeeping data shall be collected and transmitted.

SRDC3.1.5.2-3
Calibrations shall be done during regular operations.

3.1.5.3 Sensor Diagnostic Mode

SRDC3.1.5.3-1
The Sensor Diagnostic Mode shall include trouble shooting and software updates.

3.1.5.4 Sensor Safe Hold Mode

In the Safe Hold Mode, health and status data are collected and transmitted. Mission and calibration data are not collected. The Safe Hold Mode is a power conservation mode.

SRDC3.1.5.4-1
The Sensor shall accept a command in the event the spacecraft enters an anomalous configuration or orientation as determined by the spacecraft computer. A power subsystem anomaly is such an event. The C&DH will issue power conservation re-configuration commands to the sensors via the data bus that will place the sensor in a safe configuration. The return to the Sensor Operations Mode requires ground intervention.

SRDC3.1.5.4-2
In this mode most subsystems shall be turned off, with survival heaters activated.

3.1.5.5 CMIS Specific Sensor Modes (TBR)

SRDC3.1.5.5-1
The CMIS contractor shall recommend to the Government additional CMIS-specific modes. The recommended modes may include System Test Mode, Storage Mode, Transport Mode, Pre-launch Mode, Launch and Ascent Mode, Deployment and Initialization Mode, and Calibration and Validation Mode.

3.1.6 Operational and Organizational Concept

3.1.6.1 Expendable Launch Vehicle Concept N/A

3.1.6.2 Launch Operations Concept

3.1.6.2.1 Pre-Launch

The CMIS sensors will be delivered and integrated onto the specified satellite platforms. During integration various CMIS verification tests will be required.

3.1.6.2.2 Launch

During launch and injection to the operational orbit, the CMIS subsystems will be powered off unless recommended otherwise by the vendor in order to provide protection from the launch and injection environments. Spacecraft telemetry to monitor vehicle status will be provided during launch and injection; transmission of launch vehicle telemetry may be used to satisfy this requirement during the launch phase. Spacecraft telemetry transmission to ground monitoring stations will be used to the extent practicable during the injection phase. After insertion into its operational orbit and separation from the launch vehicle, appropriate deployments will be initiated by memory command. Early orbit check-out will be conducted at the NPOESS primary SOC in Suitland, MD.

SRDC3.1.6.2.2-1
The contractor shall identify all CMIS specific requirements for power, telemetry,..., etc. during launch and ascent.

3.1.6.3 On-orbit Operational Concept

The NPOESS spacecraft will operate in a near circular, sun-synchronous orbit. The nominal orbit for the spacecraft is 833 km altitude, 98.7 (TBR) degree inclination. The orbit will be a "precise" orbit (i.e., altitude maintained to ± (TBD) km, nodal crossing times maintained to ± 10 minutes throughout the mission lifetime) to minimize orbital drift (precession). NPOESS must be capable of flying at any equatorial node crossing time. However, the nominal configuration is with the satellite orbits equally spaced, with 0530 and 1330 nodal crossing times for the U.S. Government spacecraft and 2130 for the EUMETSAT Meteorological Observation Satellite (METOP) spacecraft.

The sun Beta angle, β, is the angle between the solar vector (i.e. the spacecraft-sun line) and the orbit plane. For instrument thermal design purposes, the range of β for the NPOESS missions is ± 90 degrees. The satellite will maintain the sun on the appropriate side of the satellite to meet the “all beta” requirement.

SRDC3.1.6.3-1
The sensor suite design shall allow for approximately a 5 degree infringement of sun on the cold space side of the spacecraft in the case of a noon or midnight orbit.

3.1.6.3.1 On-orbit Tests

The initial on-orbit period will be devoted to a complete spacecraft checkout and the calibration and performance verifications of the payload(s), including the CMIS. The spacecraft and payload performance verification tests may be repeated at appropriate times during the operational phase of the mission.

3.1.6.3.2 On-orbit Operations (TBR)

SRDC3.1.6.3.2-1
On-orbit, the CMIS shall continuously perform all required measurements. Real-time data are continuously sent to the spacecraft for broadcast so that users within the field of view of the spacecraft data transmitters may receive the data.

SRDC3.1.6.3.2-2
The CMIS shall receive commands from the satellite as required to support the NPOESS mission.

SRDC3.1.6.3.2-3
The CMIS sensor shall be capable of operating for 21 days (with an objective of 60 days) without additional commands, i.e. autonomous operation.

3.1.7 Missions

The mission of CMIS is to provide an enduring capability for providing measurements on a global basis of various atmospheric, land and sea parameters of the Earth using microwave remote sensing techniques. The CMIS instrument will collect relevant information from a spaceborne platform, and utilize science retrieval algorithms to process that information on the ground into designated Environmental Data Records; CMIS consists of all spaceborne hardware, any ground-based test and support equipment, and the associated ground-based science algorithms. The Environmental Data Records will be disseminated to military, civil and international users of the data throughout the world. The specific measurement requirements which CMIS must perform are identified in the assigned Primary EDRs and Secondary EDRs. These requirements have been prepared in coordination with, and approved by, the Departments of Defense and Commerce.

3.2 SENSOR SUITE CHARACTERISTICS

3.2.1 Performance Characteristics

SRDC3.2.1-1
The performance characteristics of the CMIS shall be developed by the vendor based upon the data product requirements of the EDRs assigned to the CMIS and any other requirements specified herein.

SRDC3.2.1-2
Sensor level requirements shall be derived by the contractor based on a flowdown of EDR requirements to instrument performance requirements using the contractor’s EDR science algorithms and any specification provided in the CMIS SRD.

SRDC3.2.1-3
If a derived requirement conflicts with an explicit requirement and/or another requirement, the most stringent requirement shall be satisfied.

SRDC3.2.1-4
Unless otherwise specified, all performance requirements within Section 3.2.1 shall be met over the design service life of the CMIS and under all operational environmental conditions.

3.2.1.1 Performance Requirements

3.2.1.1.1 EDR Requirements

SRDC3.2.1.1.1-1
The environmental data records listed in Section 3.2.1.1.1.1 are the measurement requirements which shall be satisfied by CMIS. Please note that the EDR requirements specified in Paragraph 3.2.1.1.1.1 may have different Thresholds and/or Objectives than the values contained in Appendix D of this SRD and/or Appendix D of the NPOESS TRD.
Note: Supplemental information concerning conventions/general EDR requirements can be found in Section 40.1 of Appendix D and are to be followed unless found to be in conflict with modifications and clarifications of EDR requirements identified in this section.

SRDC3.2.1.1.1-2
In the event of conflict the values specified in Paragraph 3.2.1.1.1.1 shall take precedence.

SRDC3.2.1.1.1-3
As a minimum, the EDR requirements shall be satisfied at the threshold level.

SRDC3.2.1.1.1-4
In the event the requirements for an EDR cannot be fully satisfied, the contractor shall identify the requirements which are not fully satisfied, and specify the conditions when it will not be satisfied.

SRDC3.2.1.1.1-5
The contractor shall also specify the conditions under which it recommends delivering an EDR which is incomplete and/or of degraded quality, but which is still of potential utility to one or more users.

SRDC3.2.1.1.1-6
The CMIS contractor shall identify specifications for any data required from other sources in order to meet the attribute requirements of the primary EDRs assigned to the CMIS sensor.

3.2.1.1.1.1 EDR Requirements

Identified below are the EDRs which CMIS must satisfy. The EDRs have been grouped into Primary and Secondary EDRs. The attribute numbering is consistent with Appendix D except for the preface letter which indicates it is a unique requirement in this SRD. Any difference in these attributes take precedence over Appendix D values as they reflect an intentional requirements allocation to this sensor.

SRDC3.2.1.1.1.1-1
For the EDRs appended with “(cloudy)” listed below, CMIS shall satisfy the EDR Thresholds associated with cloudy conditions under all measurement conditions, i.e. in clear conditions, cloudy conditions, or any amount of cloud cover.

SRDC3.2.1.1.1.1-2
The requirements for data to be provided by other sensors to CMIS (i.e. other sensor Secondary EDRs) shall be defined by the CMIS contractor no later than 60 days prior to each of the other sensors’ Systems Requirements Review (SRR).

SRDC3.2.1.1.1.1-3
Requirements for the following Primary EDRs shall be satisfied using sensing data acquired by the CMIS and science algorithms developed by the CMIS contractor. The science algorithm may or may not require the use of additional data from other than CMIS.

SRDC3.2.1.1.1.1-4
The contractor shall advise the government of data requirements from sources external to CMIS.

Atmospheric Vertical Moisture Profile   App D Section 40.2.1

An atmospheric vertical moisture profile is a set of estimates of the average mixing ratio in three-dimensional cells centered on specified points along a local vertical. The mixing ratio of a sample of air is the ratio of the mass of water vapor in the sample to the mass of dry air in the sample.

Para. No.		Thresholds	Objectives
C40.2.1-1	a. Horizontal Cell Size	15 km	2 km
C40.2.1-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.2.1-3	c. Vertical Cell Size	2 km	2 km
	d. Vertical Reporting Interval		
C40.2.1-4	1. surface to 850 mb	20 mb	5 mb
C40.2.1-5	2. 850 mb to 100 mb	50 mb	15 mb
C40.2.1-6	e. Horizontal Coverage	Global	Global
C40.2.1-7	f. Vertical Coverage	Surface to 100 mb	Surface to 100 mb
C40.2.1-8	g. Measurement Range	0 - 30 g/kg	0 - 30 g/km
	h. Measurement Uncertainty (expressed as a percent of average mixing ratio in 2 km layers)		
	Clear		
C40.2.1-9	1. surface to 600 mb	20% or 0.2g/kg (TBR)	10%
C40.2.1-10	2. 600 mb to 300 mb	35% or 0.1g/kg(TBR)	10%
C40.2.1-11	3. 300 mb to 100 mb	35% or 0.1g/kg(TBR)	10%
	Cloudy (TBR)		
C40.2.1-12	4. surface to 600 mb	20 % or 0.2g/kg (TBR)	10%
C40.2.1-13	5. 600 mb to 300 mb	40% or 0.1g/kg	10%
C40.2.1-14	6. 300 mb to 100 mb	40 % or 0.1g/kg(TBR)	10%
C40.2.1-15	i. Mapping Uncertainty	5 km	1 km
C40.2.1-16	j. Swath Width	1700 km (TBR)	(TBD)

Atmospheric Vertical Temperature Profile   App D Section 40.2.2

An atmospheric temperature profile is a set of estimates of the average atmospheric temperature in three-dimensional cells centered on specified points along a local vertical.

Para. No.		Thresholds	Objectives
	a. Horizontal Cell Size		
C40.2.2-1	1. Clear, nadir	40 km	5 km
C40.2.2-2	2. Clear, worst case	40 km	(TBD)
C40.2.2-3	3. Cloudy	40 km	5 km
C40.2.2-4	4. Cloudy, worst case	40 km	(TBD)
C40.2.2-5	b. Horizontal Reporting Interval	(TBD)	(TBD)
	c. Vertical Cell Size		
	Clear		
C40.2.2-6	1. surface to 300 mb	1 km	(TBD)
C40.2.2-7	2. 300 mb to 30 mb	3 km	(TBD)
C40.2.2-8	3. 30 mb to 1 mb	5 km	(TBD)
C40.2.2-9	4. 1 mb to 0.01 mb	5 km	(TBD)
	Cloudy		
C40.2.2-10	5. surface to 700 mb	1 km	(TBD)
C40.2.2-11	6. 700 mb to 300mb	1 km	(TBD)
C40.2.2-12	7. 300 mb to 30 mb	3 km	(TBD)
C40.2.2-13	8. 30 mb to 1 mb	5 km	(TBD)
C40.2.2-14	9. 1 mb to 0.01 mb	5 km	(TBD)
	d. Vertical Reporting Interval		
C40.2.2-15	1. surface to 850 mb	20 mb	15 mb
C40.2.2-16	2. 850 mb to 300 mb	50 mb	15 mb
C40.2.2-17	3. 300 mb to 100 mb	25 mb	15 mb
C40.2.2-18	4. 100 mb to 10 mb	20 mb	10 mb
C40.2.2-19	5. 10 mb to 1 mb	2 mb	1 mb
C40.2.2-20	6. 1 mb to 0.1 mb	0.2 mb	0.1 mb
C40.2.2-21	7. 0.1 mb to 0.01 mb	0.02 mb	0.01 mb
C40.2.2-22	e. Horizontal Coverage	Global	Global
C40.2.2-23	f. Vertical Coverage	surface to 0.01 mb	Surface to 0.01mb
C40.2.2-24	g. Measurement Range	180-335K (TBR)	(TBD)
C40.2.2-25	h. Measurement Uncertainty		0.5 K
	Clear		
C40.2.2-26	1. surface to 300 mb	1.6 K/ 1 km layers	0.5K/1km
C40.2.2-27	2. 300 mb to 30 mb	1..5 K/ 3 km layers	0.5K/1km
C40.2.2-28	3. 30 mb to 1 mb	1.5 K/ 5 km layers	0.5K/1km
C40.2.2-29	4. 1 mb to 0.01 mb	3.5 K/ 5 km layers	0.5K/1km
	Cloudy (TBR)		
C40.2.2-30	5. surface to 700 mb	2.5 K/ 1 km layers	0.5K/1km
C40.2.2-31	6. 700 mb to 300 mb	1.5 K/ 1 km layers	0.5K/1km
C40.2.2-32	7. 300 mb to 30 mb	1.5 K/ 3 km layers	0.5K/1km
C40.2.2-33	8. 30 mb to 1 mb	1.5 K/ 5 km layer	0.5K/1km
C40.2.2-34	9. 1 mb to 0.01 mb	3.5 K/ 5 km layers	0.5K/1km
C40.2.2-35	i. Mapping Uncertainty	5 km	1 km
C40.2.2-36	j. Swath Width	1700 km (TBR)	(TBD)

Imagery   App D Section 40.2.3

SRDC3.2.1.1.1.1-5
Brightness temperature data from each microwave channel shall be available for display at the sampled resolution. The threshold horizontal spatial resolution (HSR) is to be consistent with the performance of the related EDRs The display capability for all imagery should be consistent with the dynamic range of any CMIS channel.

Para. No.		Thresholds	Objectives
	a. Horizontal Spatial Resolution		
C40.2.3.1-1	1. Global	Consistent with related EDRs	(TBD)
C40.2.3.1-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
	c. Horizontal Coverage		
C40.2.3.1-3	1. Global	Global	Global
C40.2.3.1-4	2. Regional	Up to 1/2 orbit, non-contiguous, commandable by SOC	Up to 1/2 orbit, non-contiguous, commandable by SOC
C40.2.3.1-5	d. Measurement Range	Dynamic range of all measurement channels	Dynamic range of all measurement channels
C40.2.3.1-6	e. Measurement Uncertainty (TBR)	Derived	Derived
C40.2.3.1-7	f. Mapping Uncertainty	3 km (TBR)	(TBD)

Sea Surface Temperature (SST)   App D Section 40.2.4

Sea surface temperature (SST) is defined as the skin temperature of the ocean surface water. The measured radiances should enable the derivation of both skin and surface layer (1 meter depth) sea surface temperature to the specifications listed below, though an EDR algorithm is only required for skin temperature.

Para. No.		Thresholds	Objectives
	a. Horizontal Cell Size		
C40.2.4-1	1. Global	50 km	1 km
C40.2.4-2	2. Global, worst case	50 km	(TBD)
C40.2.4-3	3. Regional	50 km	0.25 km
C40.2.4-4	4. Regional, worst case	50 km	(TBD)
C40.2.4-5	b. Horizontal Reporting Interval	Local Horizontal Cell Size	Local Horizontal Cell Size
	c. Horizontal Coverage		
C40.2.4-6	1. Global	Oceans	Oceans
C40.2.4-7	2. Regional	Oceans, up to 1/2 orbit, non-contiguous, commandable by SOC	Oceans, up to 1/2 orbit, non-contiguous, commandable by SOC
C40.2.4-8	d. Measurement Range	271 K - 313 K	271 K - 313 K
C40.2.4-9	e. Measurement Uncertainty (TBR)	0.5 K (TBR)	0.1 K
C40.2.4-10	f. Measurement Accuracy	(TBD)	0.1 K
C40.2.4-11	g. Measurement Precision	(TBD)	0.1K
	h. Mapping Uncertainty		
C40.2.4-12	1. Global	5 km	0.5 km
C40.2.4-13	2. Global, worst case	5 km	(TBD)
C40.2.4-14	3. Regional	5 km	0.1 km
C40.2.4-15	4. Regional, worst case	5 km	(TBD)
C40.2.4-16	i. Swath Width	1700 km (TBR)	(TBD)

Sea Surface Winds (Speed and Direction)   App D Section 40.2.5

Atmospheric wind speed and direction at the sea/atmosphere interface. This parameter is to be reported at 19.5 meters above sea level.

Para. No.		Thresholds	Objectives
C40.2.5-1	a. Horizontal Cell Size	20 km	1 km
C40.2.5-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.2.5-3	c. Horizontal Coverage	Oceans	Oceans
	d. Measurement Range		
C40.2.5-4	1. Speed	3 - 25 m/s	1 - 50 m/s
C40.2.5-5	2. Direction	0 - 360 deg	0 - 360 deg
	e. *Measurement Accuracy		
C40.2.5-6	1. Speed	2 m/s or 20 % of true value, whichever is greater	1 m/s or 10 % of true value, whichever is greater
C40.2.5-7	2. Direction (TBR)	20 deg for wind speeds greater than 8 m/s. 45 deg(TBR) for wind speeds less than 8 m/s	10 deg
	f. Measurement Precision		
C40.2.5-8	1. Speed	1 m/s	1 m/s
C40.2.5-9	2. Direction	10 deg	10 deg
C40.2.5-10	g. Mapping Uncertainty	5 km	1 km
C40.2.5-11	h. Swath Width	1700 km	(TBD)

Soil Moisture   App D Section 40.2.6

Total water in all phases in the soil or in a surface layer over soil. The threshold requirement is to measure soil moisture only within a thin layer at the surface (0.1 cm thick) and only for bare soil in regions with known soil types. The objective is to measure a moisture profile for any soil, whether bare or not, and whether or not the soil type is known.

Para. No.		Thresholds	Objectives
	a. Horizontal Cell Size		
C40.2.6-1	1. Clear	40 km	(TBD)
C40.2.6-2	3. Cloudy	40 km	2 km
C40.2.6-3	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.2.6-4	c. Vertical Cell Size	0.1 cm	5 cm
C40.2.6-5	d. Vertical Reporting Interval	N/A (single value reported)	5 cm
C40.2.6-6	e. Horizontal Coverage	Land	Land
C40.2.6-7	f. Vertical Coverage (TBR)	surface to -0.1 cm (skin layer)	Surface to -80 cm
C40.2.6-8	g. Measurement Range	0 - 100 cm/m (TBR)	0 - 100 cm/m
	h. Measurement Uncertainty		
C40.2.6-9	1. Clear, Bare soil in regions with known soil types (smaller horizontal cell size)	10 cm/m (TBR)	Surface: 1 cm/m Total 80 cm column: greater of 5% or 0.013 cm/m (130 g/m^3)
C40.2.6-10	2. Cloudy , Bare soil in regions with known soil types (greater horizontal cell size)	20 cm/m (TBR)	Surface: 1 cm/m Total 80 cm column: greater of 5% or 0.013 cm/m (130 g/m^3)
C40.2.6-11	i. Mapping Uncertainty	3 km	1 km
C40.2.6-12	j. Swath Width	1700 km (TBR)	(TBD)

Precipitable Water   App D Section 40.3.3

The requirements below apply under both clear and cloudy conditions. Precipitable water is defined as the total equivalent water in a vertical column of the atmosphere per unit cross-sectional area.

Para. No.		Thresholds	Objectives
C40.3.3-1	a. Horizontal Cell Size	25 km (TBR)	1 km
C40.3.3-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.3.3-3	c. Horizontal Coverage	Global	Global
C40.3.3-4	d. Measurement Range	0 - 75 mm	0 - 100 mm
C40.3.3-5	e. Measurement Accuracy	greater of 10 % or 2 mm	1 mm
C40.3.3-6	f. Measurement Precision	1 mm	1 mm
C40.3.3-7	g. Mapping Uncertainty	3 km	0.1 km
C40.3.3-8	h. Swath Width	1700 km (TBR)	(TBD)

Precipitation (Type, Rate)   App D Section 40.3.4

The required data products are precipitation rate and identification of type as rain or ice. The requirements in the table below apply under both clear and cloudy conditions.

Para. No.		Thresholds	Objectives
C40.3.4-1	a. Horizontal Cell Size	15 km (TBR)	0.1 km
C40.3.4-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.3.4-3	c. Horizontal Coverage	Global	Global
	d. Measurement Range		
C40.3.4-4	1. Precipitation Rate	0 - 50 (TBR) mm/hr	0 - 250 mm/hr
C40.3.4-5	2. Precipitation Type	rain and ice	rain and ice
C40.3.4-6	e. Measurement Accuracy, Precip. Rate	2 mm/hr	2 mm/hr
C40.3.4-7	f. Measurement Precision, Precip. Rate	1 mm/hr	1 mm/hr
C40.3.4-8	g. Correct Typing Probability, Precip. Type	(TBD) %	(TBD) %
C40.3.4-9	h. Mapping Uncertainty	3 km	0.1 km
C40.3.4-10	i. Swath Width	1700 km (TBR)	(TBD)

Pressure Profile (TBR)   App D Section 40.3.5

A pressure profile is a set of estimates of the atmospheric pressure at specified altitudes above the earth's surface. The requirements below apply under both clear and cloudy conditions.

Para. No.		Thresholds	Objectives
C40.3.5-1	a. Horizontal Cell Size	25 km	5 km
C40.3.5-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.3.5-3	c. Vertical Cell Size	1 km	0 km
	d. Vertical Reporting Interval		
C40.3.5-4	1. 0 - 2 km	1 km	0.25 km
C40.3.5-5	2. 2 - 5 km	1 km	0.5 km
C40.3.5-6	3. > 5 km	1 km	1 km
C40.3.5-7	e. Horizontal Coverage	Global	Global
C40.3.5-8	f. Vertical Coverage	0 - 30 km	0 - 30 km
C40.3.5-9	g. Measurement Range	10 - 1050 mb	10 - 1050 mb
	h. Measurement Accuracy		
C40.3.5-11	1. 0 - 10 km	5 % (TBR)	3 % (TBR)
C40.3.5-12	2. 10 - 30 km	10 % (TBR)	5 %
C40.3.5-13	i. Measurement Precision	4 mb	2 mb
C40.3.5-14	k. Mapping Uncertainty	7 km	1 km
C40.3.5-15	l. Swath Width	1700 km (TBR)	(TBD)

Total Water Content   App D Section 40.3.6

Total water content is defined as the water vapor, cloud liquid water, and cloud ice liquid equivalent in specified segments of a vertical column of the atmosphere. For this EDR vertical cell size is the vertical height of the column segment and the vertical reporting interval specifies the locations of the column segment bottoms for which cloud liquid water must be reported. The requirements below apply under both clear and cloudy conditions.

Para. No.		Thresholds	Objectives
C40.3.6-1	a. Horizontal Cell Size	20 km	10 km
C40.3.6-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.3.6-3	c. Vertical Cell Size (TBR)	3 km	1 km
C40.3.6-4	d. Vertical Reporting Interval	Vertical cell size	Vertical cell size
C40.3.6-5	e. Horizontal Coverage	Global	Global
C40.3.6-6	f. Vertical Coverage	0 - 20 km	0 - (TBD) km
C40.3.6-7	g. Measurement Range	0-200 kg	(TBD)
	h. Measurement Uncertainty		
C40.3.6-8	1. Point Measurement	2 kg/m^2	(TBD)
C40.3.6-9	2. Global Average	1 kg/m^2(TBR)	(TBD)
C40.3.6-10	i. Mapping Uncertainty	7 km	7 km
C40.3.6-11	j. Swath Width	1700 km (TBR)	(TBD)

Cloud Base Height (TBR)   App D Section 40.4.1

Cloud base height is defined as the height above ground level where cloud bases occur. More precisely, for a cloud covered earth location, cloud base height is the set of altitudes of the bases of the clouds that intersect the local vertical at this location. The reported heights are horizontal spatial averages over a cell, i.e., a square region of the earth's surface. If a cloud layer does not extend over an entire cell, the spatial average is limited to the portion of the cell that is covered by the layer. As a threshold, only the height of the base of the lowest altitude cloud layer is required and objective is to report cloud base height for all distinct cloud layers.

Para. No.		Thresholds	Objectives
C40.4.1-1	a. Horizontal Cell Size	25 km	10 km
C40.4.1-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.4.1-3	c. Horizontal Coverage	Global	Global
	d. Vertical Cell Size	N/A	N/A
C40.4.1-4	e. Vertical Reporting Interval	Total Column	0.25km
C40.4.1-5	f. Measurement Range	0 - 15 km	0 - 30 km
C40.4.1-6	g. Measurement Uncertainty	2 km (TBR)	0.25 km
C40.4.1-7	h. Mapping Uncertainty	5 km	1 km
C40.4.1-8	i. Swath Width	1700 km (TBR)	(TBD)

Cloud Ice Water Path   App D Section 40.4.4

Cloud ice water path is defined as the equivalent amount of water within cloud ice particles in a specified segment of a vertical column of the atmosphere. For this EDR, vertical cell size is the vertical height of the column segment and the vertical reporting interval specifies the locations of the column segment bottoms for which cloud ice water path must be reported.

Para. No.		Thresholds	Objectives
C40.4.4-1	a. Horizontal Cell Size	50 km	10 km
C40.4.4-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.4.4-3	c. Vertical Cell Size	15 km (Total Column)	Vertical Reporting Interval
C40.4.4-4	d. Vertical Reporting Interval	N/A (Total Column)	0.3 km
C40.4.4-5	e. Horizontal Coverage	Global	Global
C40.4.4-6	f. Vertical Coverage	0 - 20 km	0 - 20 km
C40.4.4-7	g. Measurement Range	0 - 2.6 kg/m^2 (TBR)	0 - 10 kg/m^2
C40.4.4-8	h. Measurement Accuracy	10 % or $5g/m^2$ (TBR)	5 %
C40.4.4-9	i. Measurement Precision	5 %	2 %
C40.4.4-10	j. Long Term Stability	2 %	1 %
C40.4.4-11	k. Mapping Uncertainty	4 km	1 km
C40.4.4-12	l. Swath Width	1700 km (TBR)	(TBD)

Cloud Liquid Water   App D Section 40.4.5

Cloud liquid water is defined as the equivalent amount of water within cloud particles in a specified segment of a vertical column of the atmosphere. For this EDR, vertical cell size is the vertical height of the column segment and the vertical reporting interval specifies the locations of the column segment bottoms for which cloud liquid water must be reported.

Para. No.		Thresholds	Objectives
C40.4.5-1	a. Horizontal Cell Size	20 km	5 km
C40.4.5-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.4.5-3	c. Vertical Cell Size	20 km (Total Column)	Vertical Reporting Interval
C40.4.5-4	d. Vertical Reporting Interval	N/A (Total Column)	0.3 km
C40.4.5-5	e. Horizontal Coverage	Global	Global
C40.4.5-6	f. Vertical Coverage	0 - 30 km	0 - 30 km
C40.4.5-7	g. Measurement Range	0 - 50 mm	(TBD)
	h. Measurement Uncertainty(TBR)		
C40.4.5-8	1. Over ocean	0.25 mm	0.01 mm
C40.4.5-9	2. Over land	0.5 mm	0.01 mm
C40.4.5-10	i. Mapping Uncertainty	7 km	1 km
C40.4.5-11	j. Swath Width	1700 km (TBR)	(TBD)

Snow Cover/Depth   App D Section 40.6.3

Horizontal and vertical extent of snow cover. As a threshold, only the fraction of snow cover in the specified horizontal cell (clear or cloudy) is required, regardless of depth. As an objective, fraction of snow cover for snow having a specified minimum depth is required in the specified horizontal cell (clear or cloudy) for a set of specified minimum depths.

Para. No.		Thresholds	Objectives
	a. Horizontal Cell Size (TBR)		
C40.6.3-1	1. Clear - daytime	12.5 km	1 km
C40.6.3-2	2. Cloudy and/or nighttime	12.5 km	1 km
C40.6.3-3	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.6.3-4	c. Snow Depth Ranges	> 0 cm (Any Snow Thickness)	> 8 cm, > 15 cm, > 30 cm, >51 cm, >76 cm
C40.6.3-5	d. Horizontal Coverage	Land	Land & Ice
C40.6.3-6	e. Vertical Coverage	0 - 40 cm	0 - 1 m
C40.6.3-7	f. Measurement Range	0 - 1 per snow depth category	0 - 1 per snow depth category
	g. Measurement Uncertainty(TBR)		
C40.6.3-8	1. Clear - daytime	10% (snow/no snow)	10% for snow depth
C40.6.3-9	2. Cloudy and/or nighttime	20% (snow/no snow)	(TBD)
	h. Mapping Uncertainty		
C40.6.3-10	1. Clear	2 km	1 km
C40.6.3-11	2. Cloudy	7 km	1 km
C40.6.3-12	k. Swath Width	1700 km (TBR)	(TBD)

Fresh Water Ice   App D Section 40.7.2

Fresh water ice concentration is defined as the fraction of a given area of fresh water that is covered by ice, quantized to the nearest one tenth. Ice edge boundary is the contour separating fresh water from fresh water ice. The error in ice edge boundary location is defined as the distance between a measured boundary point and the nearest point on the true ice edge boundary. The measurement uncertainty requirement on ice edge boundary limits this error.

Para. No.		Thresholds	Objectives
	a. Horizontal Cell Size		
C40.7.2-1	1. Regional, nadir	20 km (TBR)	(TBD)
C40.7.2-2	2. Regional, worst case	20 km (TBR)	(TBD) 0.65 km
C40.7.2-3	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.7.2-4	c. Horizontal Coverage	Fresh Water Up to 1/2 orbit, non-contiguous, commandable by SOC	Fresh Water Up to 1/2 orbit, non-contiguous, commandable by SOC
C40.7.2-5	d. Measurement Range	1/10 to 10/10 concentration	0/10 to 10/10 concentration
C40.7.2-6	e. Measurement Uncertainty		
C40.7.2-7	1. Ice Edge Boundary	10 km	5 km
C40.7.2-8	2. Ice Concentration	20 % or 1/10	10 %
C40.7.2-9	f. Mapping Uncertainty	3 km	1 km
C40.7.2-10	g. Swath Width	1700 km (TBR)	(TBD)

Ice Surface Temperature   App D Section 40.7.3

This EDR is required under clear and cloudy conditions. As a threshold, the temperature of the surface of ice over land or water is required. The objective is to measure the atmospheric temperature 2 m above the surface of the ice.

Para. No.		Thresholds	Objectives
C40.7.3-1	a. Horizontal Cell Size	30 km	10 km
C40.7.3-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.7.3-3	c. Horizontal Coverage	Ice-covered land/water	Ice-covered land/water
C40.7.3-4	d. Measurement Range	213 K - 293 K	(TBD)
C40.7.3-5	e. Measurement Uncertainty	1 K	(TBD)
C40.7.3-6	f. Mapping Uncertainty	3 km	1 km
C40.7.3-7	g. Swath Width	1700 km (TBR)	(TBD)

Sea Ice Age and Sea Ice Edge Motion   App D Section 40.7.8

The requirements below apply under both clear and cloudy conditions. Sea ice age is defined as the time that has passed since the formation of the surface layer of an ice covered region of the ocean. The content of the sea ice age EDR is the typing of areas of sea ice by age. Sea ice motion is defined as the displacement of a sea ice edge. Definitions of the Ice Age Classes are (TBS).

Para. No.		Thresholds	Objectives
C40.7.8-1	a. Horizontal Cell Size (Ice Age)	20 km	0.1 km
C40.7.8-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.7.8-3	c. Horizontal Coverage	Oceans	Oceans
	d. Measurement Range		
C40.7.8-4	1. Ice Age Classes	First Year, Multi-year (TBR)	New, Young, First Year, and Old (TBR)
C40.7.8-5	2. Ice Motion	0-50km/day(TBR)	0 - 50 km/day
C40.7.8-6	e. Probability of Correct Typing (Ice Age)	70 %	90 %
C40.7.8-7	f. Measurement Uncertainty (Ice motion)	1 km/day	0.1 km/day
C40.7.8-8	g. Mapping Uncertainty	3 km (TBR)	1 km
C40.7.8-9	h. Swath Width	1700 km (TBR)	(TBD)

Surface Wind Stress (TBR)   App D Section 40.7.10

The requirements below apply under both clear and cloudy conditions. Surface wind stress is defined as the magnitude of the frictional stress of the wind acting on the sea surface, causing it to move as a wind-drift current, and causing the formation of waves.

Para. No.		Thresholds	Objectives
C40.7.10-1	a. Horizontal Cell Size	50 km	20 km
C40.7.10-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.7.10-3	c. Horizontal Coverage	Oceans	Oceans
C40.7.10-4	d. Measurement Range	0 - 50 N/m^2 (TBR)	0 - 50 N/m^2 (TBR)
C40.7.10-5	e. Measurement Accuracy	2 N/m^2	1 N/m^2
C40.7.10-6	f. Measurement Precision	2 N/m^2	1 N/m^2
C40.7.10-7	g. Mapping Uncertainty	7 km	1 km (TBR)
C40.7.10-8	i. Swath Width	1700 km (TBR)	(TBD)

Land Surface Temperature   App D Section 40.6.1

Land surface temperature (LST) is defined as the skin temperature of the uppermost layer of the land surface.

Para. No.		Thresholds	Objectives
C40.6.1-1	a. Horizontal Cell Size	50 km (TBR)	1 km
C40.6.1-2	b. Horizontal Reporting Interval	(TBD)	(TBD)
C40.6.1-3	c. Horizontal Coverage	Land	Land
C40.6.1-4	d. Measurement Range	213 K - 343 K	213 K - 343 K
C40.6.1-5	e. Measurement Accuracy	2.5 K	1 K
C40.6.1-6	f. Measurement Precision	0.5 K	0.025 K
C40.6.1-7	g. Mapping Uncertainty	5 km	1 km
C40.6.1-8	h. Swath Width	1700 km (TBR)	(TBD)

Vegetation /Surface Type   App D Section 40.6.4

Vegetation/surface type is defined as the predominant vegetation and/or soil type in a given area.

SRDC3.2.1.1.1.1-6
Each given area shall be classified as one of the following 21 types: crop land, brush/scrub, coniferous forest, deciduous forest, tropical forest, grass land, swamp, marsh/bog, flooded land, loam, sandy soil, clay, peat, gravel, desert, water, snow/ice, urban/developed, rocky fields, tundra, and Savannah. Estimation of the percentage of vegetation cover per type in each cell is an objective.

Para. No.		Thresholds	Objectives
	a. Horizontal Cell Size		
C40.6.4-1	1. Global	20 km	1 km
C40.6.4-2	2. Regional	20 km	0.25 km
C40.6.4-3	b. Horizontal Reporting Interval	(TBD)	(TBD)
	c. Horizontal Coverage		
C40.6.4-4	1. Global	Land	Land
C40.6.4-5	2. Regional	Land, up to 1/2 orbit, non-contiguous, commandable by SOC	Land, up to 1/2 orbit, non-contiguous, commandable by SOC
	d. Measurement Range		
C40.6.4-6	1. Vegetation/surface type	21 types specified above	21 types specified above
C40.6.4-7	2. Vegetation cover	N/A	0 - 100 %
C40.6.4-8	e. Measurement Accuracy (veg. cover)	N/A	2 %
C40.6.4-9	f. Measurement Precision (veg. cover)	N/A	0.1 %
C40.6.4-10	g. Correct Typing Probability (vegetation /surface type)	70 %	(TBD)
C40.6.4-11	h. Mapping Uncertainty	5 km	1 km
C40.6.4-12	i. Swath Width	1700 km (TBR)	(TBD)

Secondary EDRs

The data products for Secondary EDRs have been assigned to sensors other than CMIS as Primary EDRs, but these EDRs may require CMIS data to process the associated algorithms.
(TBS)

SRDC3.2.1.1.1.1-7
The CMIS shall meet (TBS) data specifications for the generation of secondary EDRs. The CMIS contractor will be advised by the Government of CMIS data requirements identified by other NPOESS sensor contractors after award of contract, and after the other sensor vendors advise the Government of their requirements.

3.2.1.1.1.2.2 Data Bases and Model Computation (TBR)

SRDC3.2.1.1.1.2.2-1
The contractor shall include in his requirements flowdown analysis uncertainties in data from any data bases that are relied upon in generating EDRs.

SRDC3.2.1.1.1.2.2-2
If the contractor determines that these uncertainties prevent a threshold requirement from being met, if reliance on the data base is deemed necessary by the contractor, and if the data base varies in time, e.g., is updated in near real time, and is not under the control of the contractor, then the contractor shall so notify the government and the government will determine the appropriate remedial action.

SRDC3.2.1.1.1.2.2-3
If a fixed data base, e.g., one addressing terrain, is needed, and existing data bases are not adequate to allow thresholds to be met, the contractor shall generate a new data base or partial data base having the characteristics necessary to demonstrate that EDR thresholds can be met.

SRDC3.2.1.1.1.2.2-4
The contractor shall identify and quantify any EDR performance degradation resulting from the lack of availability of any data base or other ancillary data.

3.2.1.1.2 Sensor Data Record (SDR) Requirements (TBR)

3.2.1.1.2.1 Definition

The Sensor Data Record (SDR) is defined in Appendix A.

3.2.1.1.2.2 Requirements

SRDC3.2.1.1.2.2-1
The CMIS vendor shall provide to the Interface Data Processor Segment (IDPS) the algorithms and sensor data necessary to process TDR data into SDR data.

SRDC3.2.1.1.2.2-2
The operational SDR data shall contain as a minimum the following data and information:

Brightness Temperature data for each channel
Geolocation data for each sample: geodetic latitude and longitude
Spacecraft ID tag
CMIS sensor ID or serial number
Flight software version number
Orbit number
Beginning Julian day and time tag
Ending Julian day and time tag
Ascending Node Julian day and time tag

Time tag information - beginning of scan time
Scan index

SRDC3.2.1.1.2.2-3
The CMIS contractor shall recommend additional information and data to be included in the SDR.

3.2.1.1.3 Temperature Data Record (TDR) Requirements (TBR)

3.2.1.1.3.1 Definition

The Temperature Data Record (TDR) is defined in Appendix A.

3.2.1.1.3.2 Requirements

SRDC3.2.1.1.3.2-1
The CMIS vendor shall provide to the IDPS the algorithms and sensor data necessary to process RDR data into TDR data.

SRDC3.2.1.1.3.2-2
The operational TDR data shall contain as a minimum the following data and information:
Antenna Temperature data for each channel and sample
Sensor health and status data: limited to that necessary to assess performance and compute Sensitivity
Sensor calibration data
Spacecraft ID tag
CMIS sensor ID or serial number
Flight software version number
Orbit number
Beginning Julian day and time tag
Ending Julian day and time tag
Ascending Node Julian day and time tag
Satellite Ephemeris data: sufficient to geolocate each data sample
Time tag information - beginning of scan time
Scan index

SRDC3.2.1.1.3.2-3
The CMIS contractor shall recommend additional information and data to be included in the TDR.

3.2.1.1.4 Raw Data Record (RDR) Requirements (TBR)

3.2.1.1.4.1 Definition

The RDR is defined in Appendix A.
Since RDRs are processed into EDRs, RDRs are considered to have met their requirements when they are of an appropriate format and quality to be adequately processed into their associated EDRs.

3.2.1.1.4.2 Requirements

SRDC3.2.1.1.4.2-1
The RDR shall at minimum consist of the following information:
Raw data counts for each CMIS channel
Spacecraft ID tag
CMIS sensor ID or serial number
Flight software version number

Orbit number
Beginning Julian day and time tag
Ending Julian day and time tag
Ascending Node Julian day and time tag
Satellite Ephemeris data: sufficient to geolocate each data sample
Time tag information - beginning of scan time
Scan index number
Sensor calibration data
Sensor health and status data: limited to that necessary to assess performance and compute Sensitivity
CMIS mounting offset angles - needed for geolocation

SRDC3.2.1.1.4.2-2
The CMIS contractor shall recommend additional information and data to be included in the RDR.

3.2.1.1.5 Algorithms

SRDC3.2.1.1.5-1
EDR science retrieval algorithms shall be provided by the CMIS contractor.

SRDC3.2.1.1.5-2
The CMIS science retrieval algorithms shall provide EDRs which satisfy the NPOESS requirements as specified in Section 3.2.1.1.1.1. Science algorithms may also be recommended by the government's Operational Algorithm Teams (OATs).

SRDC3.2.1.1.5-3
The contractor shall identify the use of all non-CMIS data required for algorithm processing.

3.2.1.1.5.1 Convertibility to Operational Algorithms

The government considers the SDR and EDR algorithms adopted, adapted, or developed by the CMIS contractor to be scientific, rather than operational, algorithms. The CMIS contractor is not responsible for identifying or developing operational SDR and EDR algorithms for the CMIS. (Any operational algorithms necessary for the generation of RDRs will ultimately be the responsibility of the CMIS contractor, and the operational software implementing these algorithms will be part of the required flight software. This statement applies to the post-downselect phase of the CMIS program.)

SRDC3.2.1.1.5.1-1
The scientific SDR and EDR algorithms delivered by the CMIS contractor shall be convertible into operational software that is compatible with a 20 minute maximum processing time at either the DoD Centrals or DoD field terminals for the conversion of all pertinent RDRs into all required EDRs for the site or terminal, including those based wholly or in part on data from other sensor suites. The intent of this requirement is to preclude algorithms that are so computationally intensive that any foreseeable implementation would stress or exceed the time available for delivery of EDRs in an operational environment.

SRDC3.2.1.1.5.1-2
The means by which the contractor shall validate the requirement that scientific algorithms be convertible to operational software, subject to the processing time constraint specified in this Section, is (**TBD**).

SRDC3.2.1.1.5.1-3
The availability of any inputs required, from data bases or non-CMIS data sources, to generate EDRs shall be sufficient to allow EDRs to be generated at the DoD Centrals and DoD field terminals within the time constraint specified in this Section.

3.2.1.1.5.2 Performance Requirements

SRDC3.2.1.1.5.2-1
The performance of the CMIS science algorithms delivered by the CMIS contractor shall meet EDR thresholds.

SRDC3.2.1.1.5.2-2
The performance of the CMIS science algorithms shall be no worse than the performance of algorithms utilized for current operational data products for these EDRs, if such operational products exists (TBR).

3.2.1.2 CMIS Channels

3.2.1.2.1 Definition

A sensor channel is determined by the passband frequencies, bandwidths and polarization characteristics of the measurements.

3.2.1.2.2 Number of Channels

SRDC3.2.1.2.2-1
The number of channels shall be sufficient to satisfy the EDR requirements assigned to CMIS.

3.2.1.3 CMIS Frequency Bands

3.2.1.3.1 Use Of Allocated Frequency Bands

To reduce the possibility of interference from other communication/radio services, the CMIS should use frequency bands which correspond to the international allocations for Earth Exploration-Satellite and are reserved for such usage.

SRDC3.2.1.3.1-1
Utilization of other frequency bands shall be justified by analysis(es) showing significant performance and/or cost advantages.

SRDC3.2.1.3.1-2
An attempt shall be made to utilize frequency bands having the minimum possible risk of interference from other allocated radio services.

SRDC3.2.1.3.1-3
All frequency bands utilized by the CMIS shall be approval by the government.
Exceptions to this are noted in Section 3.2.1.3.2.
The frequencies listed in Table 3.2.1.3.1 are based on current (time of writing) NTIA allocations and are subject to change. The contractor should verify in conjunction with the Government the accuracy of this table, and the applicability of the frequency allocations for the time period when CMIS is planned to be operational.

SRDC3.2.1.3.1-4
The contractor shall utilize the most up-to-date information as it becomes available. (Reference Document Manual of Regulations and Procedures for Federal Radio Frequency Management, Sept. 1995).
Note that the specific frequencies and polarizations required by the CMIS are determined by the CMIS contractor as part of their design analysis and subject to the constraints discussed in this section.

SRDC3.2.1.3.1-5
The final choices for the CMIS frequency bands shall depend not only on the frequency allocations, but on phenomenological and radiometric considerations, and the necessity of meeting the EDR performance requirements in Section 3.2.1.1.1.1.

TABLE 3.2.1.3.1 FREQUENCY ALLOCATIONS FOR REMOTE SENSING

This table contains a summary of frequency band allocations involving the Earth Exploration-Satellite service (passive sensing).

Frequency band (GHz)		**Allocation**	**Notes:**
1.37	1.40	Secondary	
1.4	1.427	Exclusive	
2.69	2.70	Exclusive with exceptions	1. Some pre-existing radio services (prior to 1/1/1985) protected as primary users within Region 1
2.64	2.655	Secondary	
4.95	4.99	Secondary	
6.8		Not allocated for passive sensing	
10.6	10.7	Shared	2. The portion 10.6-10.68 GHz is exclusive passive in U.S. only; internationally, this band is shared with Fixed, and Mobile services usually with power restrictions. Aeronautical service within this band discouraged.
15.20	15.35	Secondary	
15.35	15.4	Exclusive	3. Some fixed and mobile services provided for, internationally, on a secondary basis.
18.6	18.8	Shared	4. The band 18.6 to 18.8 GHz is allocated to passive services as a shared user in Region 2, and secondary user in Region 1 and 3, shared with Fixed and Fixed Satellite to Earth. Non-government primary allocation to Fixed. Users encouraged to limit, as much as practical, their power flux density at the Earth's surface.
21.20	21.40	Exclusive	
22.21	22.5	Shared	5. The band 22.21 - 22.5 GHz is shared with fixed, and mobile services. Administrators are encouraged to take all practical steps to protect the radio astronomy service. However, passive services can not impose constraints upon the fixed or mobile services except for aeronautical mobile.
23.60	24.0	Exclusive	
31.3	31.5	Exclusive	
31.5	31.8	Shared	6. The band 31.5 - 31.8 GHz is allocated exclusively for passive sensing in the U.S. However, 31.5 - 31.8 GHz is shared with Fixed and Mobile in Regions 1 and 3. Within Regions 1 and 3, administrators are encouraged to limit frequency assignments that would cause harmful interference to passive sensing.
36.0	37.0	Shared	7. The band 36.0 - 37.0 GHz is shared with Fixed and Mobile services. Administrators are encouraged to take all practical steps to protect the spectral line observations of the radio astronomy service in the band 36.43 - 36.5 GHz.
50.2	50.4	Shared	
50.4	51.4	Not allocated for passive sensing	8. The band 50.4 - 51.4 GHz is allocated to Fixed, Fixed-Satellite (Earth-to-Space), Mobile, and Mobile Satellite (Earth-to-Space).
51.4	54.25	Exclusive	
54.25	58.0	Shared	9. The band 54.25 - 58 GHz is allocated for passive sensing, shared with Fixed, Intersatellite, and Mobile (including aeronautical mobile). In a few countries this band is

Frequency band (GHz)		Allocation	Notes:
			allocated to Radiolocation on a primary basis.
58.2	59.0	Exclusive	
59.0	64.0	Not allocated for passive sensing	10. The band 59.0 - 64 GHz is allocated for Intersatellite communications. (this band may be re-allocated.)
64.0	65.0	Exclusive	
65.0	66.0	Shared	11. The band 65.0 - 66.0 GHz is allocated for passive sensing, to be shared with the Fixed and Mobile services.
86.0	92.0	Exclusive	
92.0	95.0	Not allocated for passive sensing	12. The band 92.0 - 95 GHz is allocated to Fixed, Fixed-Satellite (Earth-to-Space), Mobile, and Radiolocation
100.0	102.0	Shared	13. The band 100-102 GHz is allocated passive, shared with Fixed, and Mobile.
105.0	116.0	Exclusive	
116.0	126.0	Shared	14. The band 116-126 GHz is allocated to passive, shared with Fixed, Intersatellite, and Mobile.
150.0	151.0	Shared	15. The bands 150-151 GHz and 174.5 - 176.5 GHz are allocated primary to passive, shared with Fixed, Fixed-Satellite (Space-to-Earth), and Mobile.
164.0	168.0	Exclusive	
174.5	176.5	Shared	15. The bands 150-151 GHz and 174.5 - 176.5 GHz are allocated primary to passive, shared with Fixed, Fixed-Satellite (Space-to-Earth), and Mobile.
182.0	185.0	Exclusive	
200.0	202.0	Shared	16. The band 200-202 GHz is allocated to passive, shared with Fixed, and Mobile.
217.0	231.0	Exclusive	
235.0	238.0	Shared	17. The band 235-238 GHz is allocated to passive, shared with Fixed, Fixed-Satellite (Space-to-Earth), and Mobile.
250.0	252.0	Exclusive	

There are no allocations above 300 GHz.

3.2.1.3.2 CMIS Frequency Bands: Exceptions

This section lists specific exceptions to the use of exclusive allocations discussed in Section 3.2.1.3.1. The CMIS contractor is not required to make use of these exceptions.

3.2.1.3.2.1 The 183 GHz Water Vapor Band (TBR)

SRDC3.2.1.3.2.1-1
Due to its heritage and recognized utility for water vapor remote sensing the CMIS contractor shall be allowed to utilize the band in the frequency range:

$$f_{center} = [183.310 - (\mathbf{TBD}), 183.310 + (\mathbf{TBD})] \text{ GHz.}$$

3.2.1.3.2.2 Additional Exceptions

Additional Exceptions are (**TBD**).

3.2.1.4 Sensitivity

3.2.1.4.1 Definition

The end-to-end radiometric sensitivity is the change in Brightness Temperature of the incident radiation at the collecting aperture required to change the mean value of the measured Brightness Temperature by one standard deviation at the digitized output of the radiometer when sampled at the rate determined by the pre-sampling filter. This is denoted as ΔT_{rms} and also referred to as Noise-Equivalent Temperature Difference (NEDT). Units are Kelvins.

3.2.1.4.2 Requirement

SRDC3.2.1.4.2-1
The ΔT_{rms} value shall be consistent with meeting all of the CMIS EDR requirements, and the requirements for radiometric accuracy.

SRDC3.2.1.4.2-2
An error analysis/budget for the CMIS pre-launch and on-orbit NEDT, which includes all relevant noise sources, shall be provided to the Government.

SRDC3.2.1.4.2-3
The sensitivity of each CMIS channel shall be measured over the range of scene Brightness Temperatures of (TBD) to (TBD).

3.2.1.5 Measurement Accuracy

3.2.1.5.1 Absolute Radiometric Accuracy

3.2.1.5.1.1 Definition

The absolute radiometric accuracy, for each CMIS channel, is defined as the difference between the brightness temperature values as measured by the CMIS when compared to a standard calibration target. The conditions under which these measurements are performed are (TBD). The units are Kelvin.

SRDC3.2.1.5.1.1-1
The absolute accuracy of the CMIS channels shall be determined by the ability to correctly measure the brightness temperature of an external calibration target having an emissivity consistent with the calibration target requirements in Section 3.2.1.10, over the temperature range of (TBD) K.

3.2.1.5.1.2 Requirement

SRDC3.2.1.5.1.2-1
The absolute radiometric measurement accuracy shall be consistent with meeting the CMIS EDR requirements and provide, at the SDR level, measured brightness temperatures accurate to within the errors specified in Table 3.2.1.5.1.2 over the CMIS dynamic range (see Section 3.2.1.6.3).

SRDC3.2.1.5.1.2-2
The CMIS calibration shall be traceable to a (TBD) calibration standard.

Table 3.2.1.5.1.2 Measurement Accuracy Requirements for each channel.

(TBD)

3.2.1.5.2 Interchannel Accuracy (TBR)

SRDC3.2.1.5.2-1
For the retrieval of certain EDRs, the relative and absolute measurement accuracy of relevant channels shall be maintained.

3.2.1.5.2.1 Definition

The interchannel accuracy is defined as the difference of the measured brightness temperature of any two relevant CMIS channels, when both channels are viewing the same standard calibration target, under identical conditions.

3.2.1.5.2.2 Requirement

SRDC3.2.1.5.2.2-1
The interchannel accuracy requirements for related sounding and surface-sensing channels are specified in Table 3.2.1.5.2.2.

SRDC3.2.1.5.2.2-2
These requirements shall be met in addition to the overall accuracy requirements listed in Section 3.2.1.5.1.

Table 3.2.1.5.2.2 CMIS Interchannel Accuracy Requirements

(TBD)

3.2.1.5.3 Polarimetric Channels

3.2.1.5.3.1 Definition

A polarimetric channel is defined as a channel that is intended to measure the third (T_U) or the fourth (T_V) Stokes parameter within the Earth’s natural polarization basis.

The four Stokes parameters in the Earth's natural polarization basis are defined in terms of the upwelling vertically- and horizontally-polarized components of the electric fields incident on the CMIS antenna(s):

$$\begin{aligned}\mathbf{T} &= [\ \langle E_v E_v^* \rangle,\ \langle E_h E_h^* \rangle,\ 2\mathrm{Re}\langle E_v E_h^* \rangle,\ 2\mathrm{Im}\langle E_v E_h^* \rangle]^T \\ &= [T_v, T_h, T_U, T_V]^T\end{aligned}$$

where E_v and E_h are the vertically- and horizontally-polarized time-varying electric fields of the incident radiation.

3.2.1.5.3.2 Accuracy Requirement

SRDC3.2.1.5.3.2-1
The radiometric accuracy of any polarimetric channels shall be consistent with meeting relevant EDR requirements listed in Section 3.2.1.1.1.1.

SRDC3.2.1.5.3.2-2
As a minimum requirement CMIS measurements of T_U and/or T_V shall be accurate to ± (TBD**)** K.

3.2.1.5.3.3 Unwanted Bias (TBR)

SRDC3.2.1.5.3.3-1
Data within the CMIS-supplied RDRs shall be supplied to enable removal (during ground data processing) of any biases in the measurement(s) of T_U and/or T_V caused by polarization mixing of the vertically- and/or horizontally-polarized channels.

SRDC3.2.1.5.3.3-2
The final T_U and/or T_V measurement shall meet all accuracy requirements for achieving the relevant CMIS EDRs and the accuracy requirements listed in Table 3.2.1.5.1.2 and Table 3.2.1.5.2.2.

3.2.1.6 Radiometer Transfer Function Requirements

3.2.1.6.1 Definition (TBR)

The CMIS Radiometer Transfer Function is defined as the function relating, for each CMIS channel, the digitized output from that channel to the brightness temperature incident on the CMIS aperture. The CMIS Radiometer Transfer Function characterizes the radiometric response of each CMIS channel to incident microwave radiation.

3.2.1.6.2 Linearity

SRDC3.2.1.6.2-1
The output of each CMIS channel shall be linear over the specified dynamic range (see Section 3.2.1.6.3), with respect to input brightness temperature.

SRDC3.2.1.6.2-2
Any deviation from an ideal linear system shall be less than (TBD) times the ΔT_{rms} (sensitivity, see Section 3.2.1.4.1 for definition) value for that CMIS channel.

3.2.1.6.3 Dynamic Range

SRDC3.2.1.6.3-1
The minimum dynamic range of each CMIS channel shall be from (TBD) to (TBD) K.

SRDC3.2.1.6.3-2
The dynamic range for all channels shall be consistent with meeting all the CMIS EDR requirements specified in Section 3.2.1.1.1.1.

3.2.1.6.4 Quantization

SRDC3.2.1.6.4-1
The quantization of each CMIS channel shall be consistent with meeting both the dynamic range and EDR requirements. The quantization error is the amount that the digital quantity differs from the analog quantity.

SRDC3.2.1.6.4-2
The quantization error of each CMIS channel shall be less than (TBD) percent of the ΔT_{rms} sensitivity, (see Section 3.2.1.4.1 for definition) value for that channel.

3.2.1.6.5 RF Pass-Band Characteristics

3.2.1.6.5.1 Definition (TBR)

The RF pass-band is defined as the continuous frequency band(s) between the lower and upper half-power attenuation points of the CMIS channel's transfer function.

3.2.1.6.5.2 Variability (pass-band ripple)

SRDC3.2.1.6.5.2-1
Within each CMIS channel passband(s), the gain as a function of frequency shall not change by an amount greater than (TBD) dB for channels primarily used for imaging or (TBD) dB for channels primarily used for sounding.

3.2.1.6.5.3 Center Frequency Stability

SRDC3.2.1.6.5.3-1
The center frequency of each of the individual CMIS channel passband(s) shall not vary by more than (TBD) percent.

3.2.1.6.6 Gain Stability

3.2.1.6.6.1 Definition (TBR)

The channel gain stability is the stability of the end-to-end radiometer gain as defined by the radiometer transfer function.

3.2.1.6.6.2 Short-Term Gain Stability

SRDC3.2.1.6.6.2-1
The CMIS channel gain shall be sufficiently stable between calibrations such that the measurement accuracy, sensitivity and EDR requirements are met.

3.2.1.6.6.3 Long-Term Gain Stability

SRDC3.2.1.6.6.3-1
In no case and under any operational conditions shall changes in the CMIS channel gain cause that channel to operate outside of its linear dynamic range.

3.2.1.6.6.4 Stability of Polarimetric Channels (TBR)

SRDC3.2.1.6.6.4-1
The CMIS channel gain of all polarimetric channels shall be sufficiently stable between calibrations to allow the measurements of T_U and/or T_V to meet all relevant EDR requirements listed in Section 3.2.1.1.1.1 and accuracy requirements listed in Section 3.2.1.5.3.

3.2.1.6.7 Channel-to-Channel Isolation

3.2.1.6.7.1 Definition

Given any pair of CMIS Channels A and B, channel-to-channel isolation is defined as the input power to CMIS Channel B divided by the power that flows into CMIS Channel A from the input power into CMIS Channel B.

3.2.1.6.7.2 Requirement

SRDC3.2.1.6.7.2-1
Channel-to-channel isolation of any two CMIS channels shall be greater than or equal to (TBD) dB at any source frequency used within a CMIS channel passband. See Section 3.2.1.9.1.4 and 3.2.1.9.2.3 for requirements on CMIS channels differing only by polarization characteristics.

3.2.1.6.8 Out-of-band Rejection

3.2.1.6.8.1 Definition

Out-of-band rejection is the level of the end-to-end response of any CMIS channel to a signal within that CMIS channel passband divided by the level of the end-to-end response to signals outside of that CMIS channel passband (see Section 3.2.1.6.5 for definition of the CMIS channel passband).

3.2.1.6.8.2 Requirement

SRD3.2.1.6.8.2-1
For CMIS channels primarily used for sounding, the passband filter(s) (either RF or IF or both) shall be such that at frequencies (TBD) times the specified half-power bandwidths away from the passband center(s) the filter gain will be a minimum of (TBD) dB below the band center value.

SRDC3.2.1.6.8.2-2
For CMIS channels primarily used for imaging, the requirements are (TBD) dB rejection at frequencies (TBD**)** times the specified passband width away from the CMIS channel center frequency.

3.2.1.7 Scan and Sampling Requirements

3.2.1.7.1 Number and Types of Scan Modes

SRDC3.2.1.7.1-1
The CMIS shall employ a conical scan mode. The conical scan geometry is shown in Figure 3.2.1.7.1. The CMIS line-of-sight (LOS) is shown by the vector $\mathbf{k}$ and is positioned at a fixed nadir angle relative to the CMIS vertical reference axis.

SRDC3.2.1.7.1-2
The CMIS nadir angle shall be (TBD) ± (TBD) degrees from the CMIS vertical reference axis. (see Section 3.2.1.8.2 and 3.2.1.12.3).

Figure 3.2.1.7.1 CMIS Scan Geometry.

(TBS)

3.2.1.7.2 Swath Width and Field of Regard

3.2.1.7.2.1 Definitions (TBR)

The CMIS sensor field of regard (FOR) is defined as the angular segment of the CMIS sensor's complete scan over which the CMIS is collecting radiance data from the Earth, and not including those angular segments used for calibration. The FOR is defined at the sensor level and is measured in degrees.

The swath width is defined as the arc-length, in meters, along a segment of a great circle on the surface of the Earth, which is locally perpendicular to the satellite ground track and extends equally on either side of the ground track. The swath width is defined at the EDR level.

3.2.1.7.2.2 Requirement

SRDC3.2.1.7.2.2-1
The swath width shall meet all EDR requirements for the CMIS sensor suite.

SRDC3.2.1.7.2.2-2
The CMIS FOR shall be sufficient to provide all the data necessary to meet the CMIS EDR requirements.

3.2.1.7.3 CMIS Horizontal Spatial Resolution and Sampling (TBR)

3.2.1.7.3.1 CMIS Horizontal Spatial Resolution

3.2.1.7.3.1.1 Definition

The CMIS horizontal spatial resolution is defined in Appendix A.

3.2.1.7.3.1.2 Requirement

SRDC3.2.1.7.3.1.2-1
The CMIS horizontal spatial resolution shall be consistent with the CMIS EDR requirements in 3.2.1.1.1.1.

3.2.1.7.3.2 CMIS Horizontal Spatial Sampling

3.2.1.7.3.2.1 Along Scan

SRDC3.2.1.7.3.2.1-1
The spatial sampling frequency for each CMIS channel shall be consistent with Nyquist criteria in the along-scan direction to ensure that all scene spatial frequencies sensed by the CMIS antenna modulation transfer function (MTF) for that channel are undistorted and appear in the digitized output data for that channel.

SRDC3.2.1.7.3.2.1-2
An analysis shall be provided which demonstrates that this requirement is satisfied.

3.2.1.7.3.2.2 Along Track

SRDC3.2.1.7.3.2.2-1
The CMIS spatial sampling frequency in the along-track direction shall be consistent with the EDR requirements in Section 3.2.1.1.1.1.

SRDC3.2.1.7.3.2.2-2
The CMIS contractor shall assess the feasibility of and provide a recommendation to the government regarding Nyquist sampling in the along track direction.

3.2.1.7.3.3 Scan Rate

SRD3.2.1.7.3.3-1
The scan rate for the CMIS conical scan shall be (TBD).

3.2.1.7.4 Pre-Sampling Filter Characteristics

SRDC3.2.1.7.4-1
The bandpass characteristics of the pre-sampling filter shall be sufficient to pass all spatial frequencies sensed by the antenna modulation transfer function without introducing distortion greater than (TBD) percent and to provide an effective integration time to meet the EDR requirements and CMIS sensor specifications for measurement sensitivity (see Section 3.2.1.4), accuracy (see Section 3.2.1.5), and horizontal spatial resolution (see Section 3.2.1.7.3).

SRDC3.2.1.7.4-2
An analysis shall be provided which demonstrates that this requirement is satisfied.

3.2.1.7.5 Scan Position Knowledge

SRDC3.2.1.7.5-1
The CMIS shall provide a measurement and readout capability to determine the angular position of the CMIS LOS in the azimuth direction relative to the satellite velocity vector.

SRDC3.2.1.7.5-2
The scan position knowledge measurement shall be accurate to (TBD) degrees and consistent with the CMIS Earth location and EDR requirements.

3.2.1.8 Antenna Requirements

3.2.1.8.1 Antenna Beam Characteristics

The antenna beam characteristics are described in terms of the Half Power Beam Width (HPBW), the main beam efficiency, pattern uniformity, and the maximum sidelobe level.

Table 3.2.1.8.1 Antenna Beam Characteristics

(TBD**)**

3.2.1.8.1.1 Antenna Half Power Beam Width

3.2.1.8.1.1.1 Definition

The HPBW is the angular width between the two directions at which the main beam gain function is one-half its maximum value within a plane containing the maximum gain of the main beam lobe.

The CMIS channel HPBW is defined by the average of the two HPBW values measured in the planes containing the along-track and along-scan directions relative to the CMIS LOS and averaged over the CMIS channel passband.

3.2.1.8.1.1.2 Requirement

SRDC3.2.1.8.1.1.2-1
The individual CMIS channel HPBW values shall be sufficient to meet the EDR requirements listed in Section 3.2.1.1.1.1.

SRDC3.2.1.8.1.1.2-2
As a minimum, the HPBW requirements in Table 3.2.1.8.1 shall be met.

3.2.1.8.1.2 Main Beam Efficiency

3.2.1.8.1.2.1 Definition

The main beam efficiency of each CMIS channel is defined as the ratio of energy received in the desired polarization over the CMIS channel passband (for passband definition see Section 3.2.1.6.5.1) within 2.5 X the CMIS channel HPBW to the total amount of energy received by the antenna within the CMIS channel passband.

3.2.1.8.1.2.2 Requirements (TBR)

SRDC3.2.1.8.1.2.2-1
An error analysis/budget for the CMIS main beam efficiencies of all channels, which includes all relevant error sources, shall be provided to the Government.

SRDC3.2.1.8.1.2.2-2
The main beam efficiency shall be no less than the values listed in Table 3.2.1.8.1 (see section 3.2.1.8.1.4).In addition, the following requirements apply:

SRDC3.2.1.8.1.2.2-3
For all CMIS channels having a center frequency less than 12 GHz, the main beam efficiency shall be no less than 92% (TBR).

SRDC3.2.1.8.1.2.2-4
For all CMIS channels having a center frequency greater than or equal to 12 GHz, the main beam efficiency shall be no less than 95% (TBR).

SRDC3.2.1.8.1.2.2-5
For all CMIS channels primarily used for sounding the main beam efficiency shall be no less than 95% (TBR).

3.2.1.8.1.3 Antenna Beam Uniformity

SRDC3.2.1.8.1.3-1
The HPBW in any plane containing the antenna main beam maximum gain for a given CMIS channel shall be within (TBD) percent of the CMIS channel HPBW (Section 3.2.1.8.1.1.1).

3.2.1.8.1.4 Maximum Relative Sidelobe Level (TBR)

3.2.1.8.1.4.1 Definition

The maximum relative sidelobe level is defined as the maximum value of the antenna gain function within any antenna sidelobe averaged over the CMIS channel passband, with respect to the maximum antenna gain averaged over the CMIS channel passband.

3.2.1.8.1.4.2 Requirement

SRDC3.2.1.8.1.4.2-1
The maximum relative sidelobe levels for each CMIS channel shall not be greater than the values listed in Table 3.2.1.8.1.

3.2.1.8.2 Beam Alignment (TBR)

The CMIS channel line-of-sight (LOS) vector is defined by the weighted center of the CMIS channel antenna beam's half power contour (in the CMIS sensor reference frame) averaged over the CMIS channel passband.

SRDC3.2.1.8.2-1
An error analysis/budget for the CMIS beam pointing accuracy and knowledge which includes all relevant error sources shall be provided.

3.2.1.8.2.1 Beam Pointing Accuracy

3.2.1.8.2.1.1 Along-track Requirement

SRDC3.2.1.8.2.1.1-1
The CMIS shall provide a LOS depression angle of (TBD) ± (TBD) degrees relative to the CMIS vertical reference axis (see Section 3.2.1.12.3).

SRDC3.2.1.8.2.1.1-2
The absolute along-track beam pointing error relative to the CMIS line-of-sight shall be less than or equal to ±(TBD) degrees.

3.2.1.8.2.1.2 Along-scan Requirement

SRDC3.2.1.8.2.1.2-1
The absolute along-scan beam pointing error relative to the CMIS line-of-sight shall be less than or equal to ±(TBD) degrees.

3.2.1.8.2.2 Beam Pointing Knowledge

3.2.1.8.2.2.1 Absolute Beam Pointing Knowledge

SRDC3.2.1.8.2.2.1-1
The absolute beam pointing knowledge of each CMIS channel, with respect to the CMIS sensor reference axes shall be less than or equal to (TBD) degrees or (TBD) percent of the antenna pattern HPBW whichever is smaller in both the along-track and along-scan directions.

3.2.1.8.2.2.2 Relative Beam Pointing Knowledge

SRDC3.2.1.8.2.2.2-1
The relative beam pointing knowledge of each CMIS channel shall be less than or equal to (TBD) degrees or (TBD) percent of the antenna pattern HPBW whichever is smaller for all relative measurements in both the along-track and along-scan directions.

3.2.1.8.2.3 Beam Co-registration (TBR)

SRDC3.2.1.8.2.3-1
Unless otherwise specified, the relative channel-to-channel beam pointing error shall be referenced to the (TBD) GHz channel antenna bean pattern centroid. At present the government is considering that the reference channel will be one of the high spatial resolution imaging channels. This will aid in the validation of beam pointing and co-registration.

SRDC3.2.1.8.2.3-2
The absolute beam pointing error shall not exceed (TBD) degrees or (TBD) percent of the co-registered channel's HPBW, whichever is smaller. However, fixed beam offsets may be utilized (multiple beams) as required in order to meet the EDR requirements (see Section 3.2.1.8.2.4).

3.2.1.8.2.4 Individual Beam Offsets

Antenna beams having fixed angular offsets from the reference channel antenna beam are allowed as required to meet EDR requirements (while still meeting the beam pointing knowledge requirements in section 3.2.1.8.2.2).

SRDC3.2.1.8.2.4-1
The fixed angular offset relative to the reference channel antenna beam shall be maintained to within ± (TBD) degrees.

3.2.1.8.2.5 Maximum Allowed Beam Alignment Change (TBR)

SRDC3.2.1.8.2.5-1
The maximum allowed antenna beam alignment change shall be less than (TBD) degrees or (TBD) percent of the CMIS channel HPBW.

3.2.1.9 Polarization Requirements (TBR)

3.2.1.9.1 Antenna Polarization Characteristics for Non-Polarimetric Channels

3.2.1.9.1.1 Definitions

The horizontal and vertical polarization vectors are defined by Equations 3-1 and 3-2 (respectively) and are shown in Figure 3.2.1.9.1.1 below.

$$\mathbf{h} = \frac{\mathbf{k} \times \mathbf{n}}{|\mathbf{k} \times \mathbf{n}|} \qquad\qquad \mathbf{v} = \mathbf{h} \times \mathbf{k}$$

EQUATION 3-1 **EQUATION 3-2**

where $\mathbf{n}$ is the geodetic local vertical (unit normal) at the Earth's surface and $\mathbf{k}$ is the unit vector in the direction of the CMIS line-of-sight.

FIGURE 3.2.1.9.1.1. Illustration of the Vertical and Horizontal Polarization Alignment and Geometry for the CMIS.

(TBS)

The plane of incidence, for a given CMIS channel, is defined as the plane containing the geodetic local vertical (**n**) and the CMIS antenna beam LOS (**k**) for that channel .

3.2.1.9.1.2 Polarization Alignment

SRDC3.2.1.9.1.2-1
Each vertically-polarized beam shall have its polarization direction lie in the plane of incidence within ±(TBD) degrees (see Figure 3.2.1.9.1.1).

SRDC3.2.1.9.1.2-2
Each horizontally-polarized beam shall have its polarization direction normal to the plane of incidence to within ±(TBD) degrees (see Figure 3.2.1.9.1.1).

SRDC3.2.1.9.1.2-3
An analysis shall be provided which demonstrates that both of the above requirements are satisfied.

3.2.1.9.1.3 Orthogonality

SRDC3.2.1.9.1.3-1
The vertically- and horizontally-polarized antenna beams shall be aligned orthogonally to within ±(TBD) degrees.

3.2.1.9.1.4 Cross Polarization Isolation

SRDC3.2.1.9.1.4-1
The integrated cross polarization rejection ratio of the orthogonal feedhorn antenna polarizations within each CMIS channel antenna beam shall be at least (TBD) dB.

3.2.1.9.2 Antenna Polarization Characteristics for Polarimetric Channels

SRDC3.2.1.9.2-1
If polarimetric channels are used then the following requirements shall apply in addition to the antenna polarization requirements in Section 3.2.1.9.1.

SRDC3.2.1.9.2-2
The antenna polarizations used by each CMIS polarimetric channel shall be consistent with performing measurements of T_U and/or T_V which will meet the sensitivity (Section 3.2.1.4), measurement accuracy (Section 3.2.1.5.3) and EDR requirements (Section 3.2.1.1.1.1).

SRDC3.2.1.9.2-3
Any antenna feedhorn(s) used for CMIS polarimetric channel(s) shall meet the minimum requirements for polarization alignment, orthogonality and cross-polarization isolation as stated below in Sections 3.2.1.9.2.1, 2, and 3.

SRDC3.2.1.9.2-4
An error analysis/budget for the CMIS polarization of all channels which includes all relevant error sources shall be provided.

3.2.1.9.2.1 Polarization Alignment for Polarimetric Channels (TBR)

SRDC3.2.1.9.2.1-1
Each vertically polarized beam shall have its polarization direction lie in the plane of incidence to within ±(TBD) degrees (see Figure 3.2.1.9.1.1).

SRDC3.2.1.9.2.1-2
Each horizontally-polarized beam shall have its polarization direction normal to the plane of incidence to within ± (TBD) degrees (see Figure 3.2.1.9.1.1).

3.2.1.9.2.2 Orthogonality Requirement for Polarimetric Channels

SRDC3.2.1.9.2.2-1
The vertically- and horizontally-polarized antenna beams shall be aligned orthogonally within (TBD) degrees.

3.2.1.9.2.3 Cross Polarization Isolation Requirement for Polarimetric Channels

SRDC3.2.1.9.2.3-1
The integrated cross polarization rejection ratio between orthogonally-polarized channels within each antenna beam shall be at least (TBD) dB.

3.2.1.9.3 Polarization Purity (TBR)

SRDC3.2.1.9.3-1
Each CMIS channel shall contain ≥ 99 percent of the specified polarization.

SRDC3.2.1.9.3-2
Each CMIS polarimetric channel shall contain ≥ (TBD) percent of the specified polarization.

3.2.1.10 Calibration (TBR)

SRDC3.2.1.10-1
The CMIS sensor shall require factory pre-launch (ground) and on-orbit calibration.

SRDC3.2.1.10-2
Any external operational calibration techniques shall not affect the normal operating and sensing performance for scene brightness temperatures through the feed system nor cause sun glint into the CMIS, or any other NPOESS sensor.

SRDC3.2.1.10-3
There shall be no time dependent feed horn effects caused by the CMIS calibration implementation, such as Voltage to Standing Wave Ratio (VSWR) changes, of such a magnitude as to cause the CMIS calibration, measurement accuracy, sensitivity and EDR requirements specified in this document not to be met.

SRDC3.2.1.10-4
Any calibration system shall have view angles and other properties that are compatible with the NPOESS spacecraft and all other on-board sensors.

3.2.1.10.1 Type of Calibration

3.2.1.10.1.1 Pre-Launch Calibration

The CMIS pre-launch calibration will consist of all tests necessary to measure and characterize the radiometric accuracy of the CMIS over the range of expected on-orbit environmental conditions and the CMIS operational states and modes. The CMIS pre-launch calibration will also provide a complete characterization and validation of the on-orbit calibration and instrument performance. The CMIS pre-launch calibration will utilize, as required the necessary calibration reference standards as calibration sources.

The CMIS pre-launch calibration will also provide a characterization and validation of the contractors calibration model. The calibration model, for each CMIS channel, will be used to relate the CMIS output to radiometric input over the dynamic range and operating conditions of the CMIS sensor.

3.2.1.10.1.2 On-orbit Calibration

The CMIS on-orbit calibration will consist of all hardware and measurements necessary to perform a calibration of each CMIS channel during on-orbit operations, at least once per scan.

SRDC3.2.1.10.1.2-1
The CMIS shall incorporate an on-orbit calibration system that uses a minimum of two signal levels (hot and cold effective scene brightness temperatures) to calibrate each CMIS channel. The calibration approach may use internal, external or any combination of sources necessary to meet the measurement accuracy requirements given in Table 3.2.1.5.1.2 and Table 3.2.1.5.2.2, and the CMIS EDR requirements.

An external cold calibration source, if used, may utilize a cold sky view.

SRDC3.2.1.10.1.2-2
The CMIS contractor shall provide the spacecraft contractor the necessary information and requirements to accommodate the clear field of view that such a target would require.

3.2.1.10.2 Frequency of Calibration

3.2.1.10.2.1 Pre-Launch Calibration

SRDC3.2.1.10.2.1-1
The pre-launch calibration shall be performed prior to CMIS delivery.

SRDC3.2.1.10.2.1-2
If the period between delivery of the CMIS and integration onto the spacecraft exceeds (TBS) months, then the pre-launch calibration shall be repeated before integration onto the spacecraft.

SRDC3.2.1.10.2.1-3
If the CMIS has been in storage prior to spacecraft integration for longer than (TBS) months then the pre-launch calibration shall be repeated before integration onto the spacecraft.

SRDC3.2.1.10.2.1-4
If the CMIS has been in storage after integration onto the spacecraft for longer than (TBS) months then the contractor shall make recommendations for any pre-launch calibration requirements.

3.2.1.10.2.2 On-orbit Calibration

SRDC3.2.1.10.2.2-1
Calibration of each CMIS channel shall occur at least once per scan.

SRDC3.2.1.10.2.2-2
The number of calibration samples taken during each scan shall be sufficient to meet all measurement accuracy, sensitivity and EDR performance requirements.

3.2.1.10.3 Calibration Source Requirements

3.2.1.10.3.1 Pre-launch Calibration

SRDC3.2.1.10.3.1-1
External thermal calibration sources suitable for the pre-launch calibration of all CMIS channels shall be provided. The external thermal calibration sources will be referred to as calibration targets.

3.2.1.10.3.1.1 Pre-Launch Calibration Target Emissivity

SRDC3.2.1.10.3.1.1-1
The pre-launch calibration target(s) shall have a minimum measured emissivity of (TBD), for each CMIS channel.

SRDC3.2.1.10.3.1.1-2
The emissivity shall be measured in accordance with the specifications given in Document (TBS).

3.2.1.10.3.1.2 Pre-Launch Calibration Target Range of Temperatures

SRDC3.2.1.10.3.1.2-1
The pre-launch calibration targets shall be capable of providing standard reference brightness temperatures over the temperature range (TBD) K to (TBD) K.

3.2.1.10.3.1.3 Pre-Launch Calibration Target Temperature

SRDC3.2.1.10.3.1.3-1
Temperature differences between any temperature controlled surface and the surface viewed by the CMIS radiometer channels shall be less than (TBS) K.

SRDC3.2.1.10.3.1.3-2
The temperature of the pre-launch calibration target shall be continuously monitored during all calibration tests using NIST traceable temperature transducers.

SRDC3.2.1.10.3.1.3-3
The temperature measurements shall be accurate to ± (TBD) K.

3.2.1.10.3.1.4 Pre-Launch Calibration Target Brightness Temperature Uniformity

SRDC3.2.1.10.3.1.4-1
The maximum brightness temperature variation over the effective aperture of the pre-launch calibration target(s) shall be less than (TBD) K at any of the brightness temperatures specified in paragraph 3.2.1.10.3.1.2. The effective aperture of the pre-launch calibration target is defined as the 90 percent energy contour of the corresponding feedhorn antenna under test.

SRDC3.2.1.10.3.1.4-2
The brightness temperature of the pre-launch calibration target(s) shall be constant to within (TBS) K during the pre-launch calibration, at any of the brightness temperatures specified in paragraph 3.2.1.10.3.1.2.

3.2.1.10.3.1.5 Pre-Launch Polarimetric Calibration Source Requirements

SRDC3.2.1.10.3.1.5-1
If the CMIS sensor includes polarimetric channels, a polarimetric calibration source shall be provided for the pre-launch calibration of the corresponding polarimetric channels.

SRDC3.2.1.10.3.1.5-2
(TBR) The polarimetric calibration source shall provide the appropriate Stokes parameters (T_U or T_V) to the CMIS feedhorn antenna with at least a dynamic range of ±10 K for T_U and ±2 K for T_V relative to the mean background brightness temperature.

SRDC3.2.1.10.3.1.5-3
The T_U or T_V signals shall be provided with an absolute accuracy of ± (TBD) K.

SRDC3.2.1.10.3.1.5-4
The polarimetric calibration source shall also provide vertically- and horizontally-polarized scene brightness temperatures over the range specified in Section 3.2.1.10.3.1.2.

3.2.1.10.3.1.6 Pre-launch Calibration of Internal Calibration Source(s)

SRDC3.2.1.10.3.1.6-1
If the CMIS sensor utilizes internal calibration source(s), the internal source calibration shall be verified by an end-to-end calibration with an external calibration target over the range of brightness temperatures specified in Section 3.2.1.10.3.1.2.

3.2.1.10.3.2 On-Orbit Calibration

SRDC3.2.1.10.3.2-1
The calibration sources employed for on-orbit calibration of the CMIS shall provide sufficiently accurate radiometric brightness temperature or noise power so as to enable the CMIS to meet all radiometric measurement accuracy requirements listed in Tables 3.2.1.5.1.2 and 3.2.1.5.2.2, and the EDR requirements in Section 3.2.1.1.1.1.

3.2.1.10.3.2.1 On-Orbit Calibration Target Emissivity

SRDC3.2.1.10.3.2.1-1
Any external on-orbit calibration targets shall have a measured emissivity of (TBD).

SRDC3.2.1.10.3.2.1-2
The external on-orbit calibration target emissivity shall be measured in accordance with the specifications given in Document (TBS).

3.2.1.10.3.2.2 On-Orbit Calibration Target Range of Effective Brightness Temperatures

SRDC3.2.1.10.3.2.2-1
The external on-orbit calibration target shall be capable of providing effective brightness temperatures over the temperature range (TBD) K to (TBD) K.

3.2.1.10.3.2.3 On-Orbit Calibration Target Temperature

SRDC3.2.1.10.3.2.3-1
Temperature differences between any temperature controlled surface and the surface viewed by the CMIS radiometer channels shall be less than (TBS) K.

SRDC3.2.1.10.3.2.3-2
The temperature of any on-orbit external calibration target shall be continuously monitored using National Institute of Standards and Technology (NIST) traceable temperature transducers.

SRDC3.2.1.10.3.2.3-3
The temperature measurements shall be accurate to ± (TBD) K.

3.2.1.10.3.2.4 On-Orbit Calibration Target Brightness Temperature Uniformity

SRDC3.2.1.10.3.2.4-1
The maximum brightness temperature variation over the effective aperture of any on-orbit calibration target(s) shall be less than (TBD) K. The effective aperture of the on-orbit calibration target is defined as the 90 percent energy contour of the corresponding feedhorn antenna under test.

SRDC3.2.1.10.3.2.4-2
The brightness temperature of any on-orbit calibration target(s) shall be constant to within ±(TBS) K during the on-orbit calibration period.

3.2.1.10.3.2.5 On-Orbit Internal Calibration Source Requirements

SRDC3.2.1.10.3.2.5-1
If internal calibration sources are to be used on-orbit, the calibration of the CMIS channels utilizing the internal calibration sources shall meet the measurement accuracy (Section 3.2.1.5) and EDR performance requirements.

3.2.1.10.4 Calibration Error Analysis

3.2.1.10.4.1 Pre-launch Calibration

SRDC3.2.1.10.4.1-1
An error analysis/budget for the CMIS pre-launch calibration which includes all relevant error sources to the pre-launch calibration shall be provided to the government.

SRDC3.2.1.10.4.1-2
The following error sources shall be included as a minimum:

- Calibration target temperature uniformity and measurement error
- Non-blackbody emissivity of calibration target
- Imperfect coupling between the feedhorn and calibration targets (e.g., unwanted energy entering the feedhorn)
- Cross-polarization coupling errors
- Antenna feedhorn spillover
- Feedhorn to reflector alignment errors
- Antenna reflector emissions
- Quantization error
- The effect of incident radiation outside of the feedhorn antenna’s 90 percent energy contour (sidelobe effects).
- Non-linear radiometer transfer function

Calibration algorithms (such as antenna pattern correction) may be required to meet calibration accuracy requirements (TBR).

3.2.1.10.4.2 On-orbit Calibration

SRDC3.2.1.10.4.2-1
An error analysis/budget for the CMIS on-orbit calibration which includes all relevant error sources to the on-orbit calibration shall be provided to the government.

SRDC3.2.1.10.4.2-2
The error sources shall include as a minimum those identified in Section 3.2.1.10.4.1.

3.2.1.11 Doppler Correction or Tracking [TBR]

The CMIS contractor should consider the effects of the relative motion of the satellite and CMIS sensor scan LOS on the retrieval of atmospheric EDRs.

SRDC3.2.1.11-1
The CMIS contractor shall account for these effects in either the CMIS hardware design or science algorithms or both.

3.2.1.12 Earth Location Requirements

3.2.1.12.1. Definition

The alignment of the CMIS relative to the spacecraft, and knowledge of the CMIS LOS in conjunction with the spacecraft attitude and ephemeris data will allow the Earth location of the CMIS sensor data.

SRDC3.2.1.12.1-1
The Earth location shall be in geodetic latitude and longitude corrected for altitude within the accuracy specified for each EDR in Section 3.2.1.1.1.1.

3.2.1.12.2 Requirements

3.2.1.12.2.1 Allocations

SRDC3.2.1.12.2.1-1
The CMIS contractor shall be responsible for meeting the EDR Earth location requirements, based on the allocations from the spacecraft level as specified in Section 3.2.4.2.1.3.

SRDC3.2.1.12.2.1-2
The CMIS contractor shall provide a complete analysis of the Earth location error budget.

SRDC3.2.1.12.2.1-3
This shall include, but is not limited to, the allocations from the spacecraft, the CMIS sensor design allocations, alignment requirements between the CMIS and the spacecraft and development and validation of the Earth location algorithm for the CMIS data.

SRDC3.2.1.12.2.1-4
The CMIS contractor shall communicate all data requirements necessary to perform this function to the IPO and prime contractor.

TABLE 3.2.1.12.2. EARTH LOCATION REQUIREMENTS ERROR BUDGET

(TBD)

3.2.1.12.3 Sensor Reference Axes Alignment

SRDC3.2.1.12.3-1
The CMIS shall have a well defined set of three orthogonal reference axes.

SRDC3.2.1.12.3-2
This set shall include a vertical reference axis.

SRDC3.2.1.12.3-3
These axes shall be used as reference axes for alignment of the CMIS LOS and the overall alignment of the CMIS to the NPOESS spacecraft. [see paragraph 3.2.1.8.2.1].

SRDC3.2.1.12.3-4
Any additional reference positions and alignment axes shall be determined by the CMIS contractor and provided to the IPO and prime contractor.

(**TBS**)

3.2.1.12.4 CMIS Line-of-Sight (LOS) Pointing Knowledge

(**TBD**)

3.2.1.12.5 CMIS LOS Jitter and Drift Requirements

3.2.1.12.5.1 Definition of Jitter

(**TBS**)

3.2.1.12.4.1.1 Requirements

(**TBD**)

3.2.1.12.5.2 Definition of Drift

(**TBS**)

3.2.1.12.5.3 Requirements

(**TBD**)

3.2.1.13 Standard Earth Scenes

The NPOESS IPO will provide up to 5 (TBR) microwave images representing different sea states and soil moisture content in each of the 20 (TBR) daytime non-desert categories/areas (diurnal variations and deserts will be neglected) listed below, for use in developing imager designs, and in verifying imager and algorithm performance. The government will create an additional set of up to 5 images in each area/category which will be used by the government to determine sensor design performance and algorithm performance.

Climate Area	Spring	Summer	Autumn	Winter	Location (NW Corner)
Polar					
Land: Siberia		X		X	70N 103E
Coast: Point Barrow		X		X	72N 159W
Tropics					
Land: Amazon Basin		X		X	5S 65W

Coast: Cameroon		X		X	5N 8E
Ocean: E. Pacific		X			8N 120W
Midlatitudes					
Land: W. Urals	X	X	X	X	56N 56E
Coast: Olympic Peninsula	X	X	X	X	48N 126W
Ocean: Azores				X	45N 30W
Alpine: Swiss Alps			X		48N 8E
Sub-Tropical: Bangladesh				X	25N 88E

Images will have a Horizontal Spatial Resolution (HSR) of 7.5 km (TBR) and will include 64X64 (TBR) pixels. The images will represent top of the atmosphere radiance in-channel for each Stokes parameter, with channels selected by the contractor to match their sensor channels. The number of image channels, including the both frequency and polarization, will not exceed 24. Contractors with more than 24 channels in their design must select which 24 channels they desire as standard scenes. After delivery of the initial set of images, contractors may request copies of the executable models and the input datasets and commands used to create the images if they wish to generate additional scenes in other channels. Sensor responsivity will be assumed to be a top-hat (TBR), since alternate sensor response functions can be characterized and calibrated out.

Sea surface data underlying the images will be constructed from a (TBS) sea surface model. Land surface data underlying the images will be constructed from a (TBS) microwave surface model. Clouds will be inserted into the images as gray body radiators with scattering as appropriate and with specified optical depth, particle size, and cloud base and top heights. Top of the atmosphere radiance values will be computed using (TBS) microwave radiance model. Image files will be supplied as binary data in raster format, with a 32 bit floating point value for each pixel, and with 1 channel and Stokes parameter per file (TBR). Files will be supplied on TAR tapes (TBR).

The NPOESS IPO will provide up to 5 sounder datasets in each of the categories/areas listed below for use in developing sounder designs, and in verifying sounder and algorithm performance. There are 24 areas in all. For each area except polar, there will be day and night categories as well, making the total 44 areas / categories (TBR) of standard datasets. The government will create an additional set of up to 5 images in each area/category which will be used by the government to determine sensor design performance and algorithm performance.

Climate Area	Spring	Summer	Autumn	Winter	Location (NW Corner)
Polar					
Land: Siberia		X		X	70N 103E
Coast: Point Barrow		X		X	72N 159W
Tropics					
Land: Amazon Basin		X		X	5S 65W
Coast: Cameroon		X		X	5N 8E
Ocean: E. Pacific		X			8N 120W
Midlatitudes					
Land: W. Urals	X	X	X	X	56N 56E
Coast: Olympic Peninsula	X	X	X	X	48N 126W
Desert: Great Basin	X	X	X	X	41N 118W
Ocean: Azores				X	45N 30W
Alpine: Swiss Alps			X		48N 8E
Sub-Tropical: Bangladesh				X	25N 88E

Sounder datasets will cover subsets from the areas identified for images. Each sounder area will consist of an area equal to 5X5 HSRs (TBR) for the channel with the largest HSR for the sensor design, but will have a HSR of 7.5 km (TBR). Datasets will provide radiance values for each channel requested by the contractor. No limit on the number of channels is specified, however, more than (TBS) channels must be justified by the contractor. The number of sounding channels modeled, including the both frequency and polarization, will not exceed 50. Contractors with more than 50 channels in their design must select which 50 channels they desire as standard sounder datasets. After delivery of the initial set of sounding datasets, contractors may request copies of the executable models and the input datasets and commands used to create the soundings if they wish to generate additional data in other channels. Sensor responsivity will be assumed to be a top-hat (TBR), since alternate sensor response functions can be characterized and calibrated out.

Radiance data will be based on ground truth profiles of temperature, water vapor, and ozone, and will be computed with (TBS) microwave radiance model for microwave channels. The temperature, water vapor, and ozone profiles will be available for each dataset given to the contractor. Cloud/no-cloud masks, at the smallest HSR, will be provided with each sounder dataset. Sounder dataset files will be supplied as binary data in raster format, with a 32 bit floating point value for each pixel, and with 1 channel per file (TBR). Files will be supplied on TAR tapes (TBR)

3.2.1.14 Data Formatting and Compression (TBR)

SRDC3.2.1.14-1
The data packets generated by the CMIS shall conform to the Consultative Committee for Space Data Systems (CCSDS) packetization per the (TBS) real time interface specification and the (TBS) stored data interface specification.

SRDC3.2.1.14-2
If data compression techniques are utilized by the CMIS in generating data packets for storage on orbit, the compression shall be lossless.

SRDC3.2.1.14-3
The CMIS may utilize lossy data compression in generating data packets for real time transmission of mission data to field terminals via either high or low data rate links, with the exception of sensor calibration data.

SRDC3.2.1.14-4
If the CMIS utilizes data compression techniques in generating data packets for real time transmission of sensor calibration data to field terminals via either high or low data rate links, the compression shall be lossless.

SRDC3.2.1.14-5
The CMIS contractor shall identify and quantify any EDR performance degradation at the field terminals resulting from the use of lossy data compression.

3.2.2 Sensor Capability Relationships

3.2.2.1 Reference Timelines

TBD

3.2.3 Interface Requirements

The system interfaces relevant to the sensors are depicted in Figure 3.2.3 below.

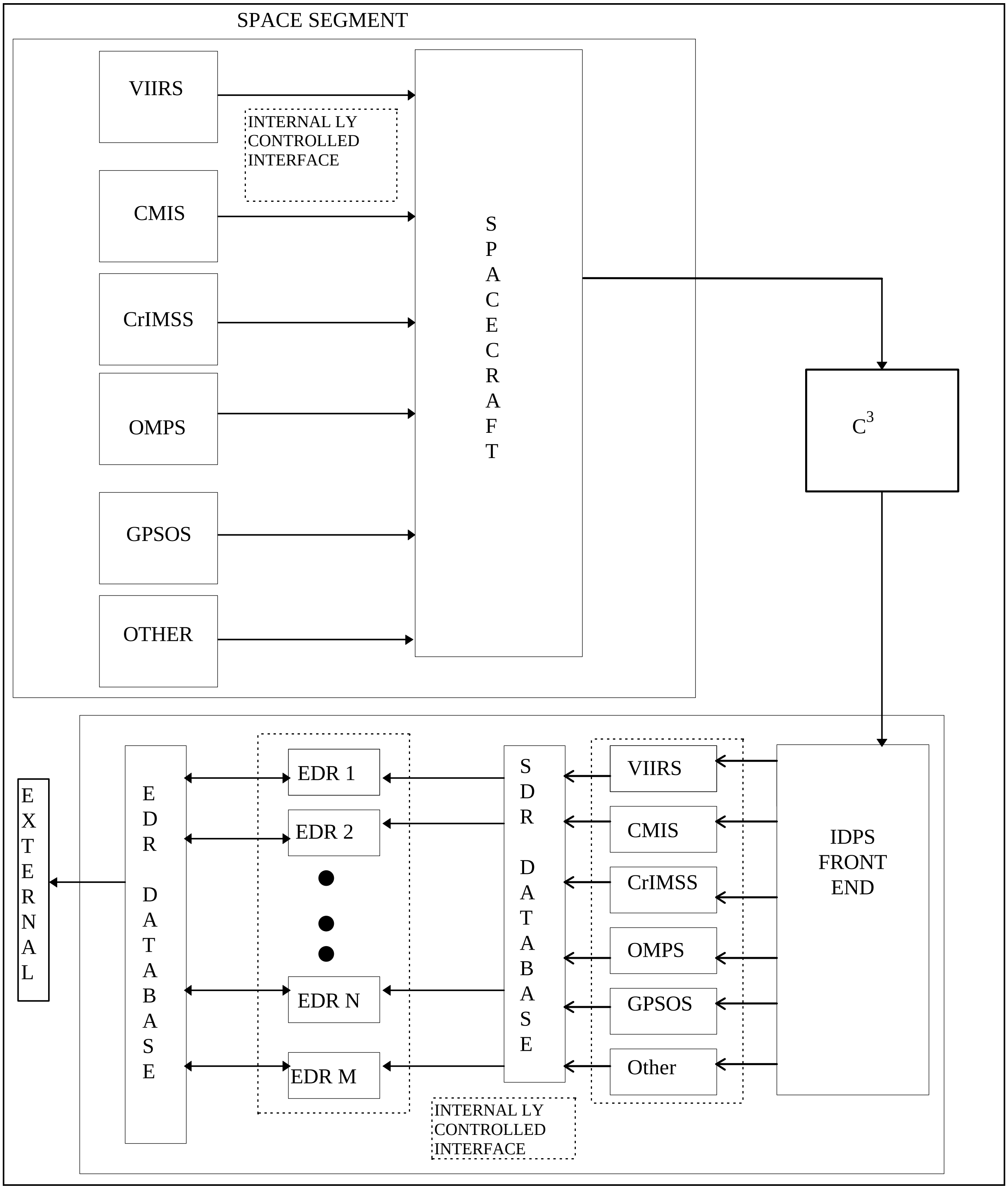


Figure 3.2.3 Partial System Internal Interfaces

3.2.4 Physical and Interface Characteristics

The weight, power, volume and data rates described herein are nominal values (with contingency) which were developed during the initial studies at the Integrated Program Office (IPO). All values are defined as TBR, indicating that specific allocations are negotiable. It is presently planned that definitive allocations will be defined by the IPO, in consultation with sensor contractors, by the time of SRR. In the interim, contractors should keep in mind that relaxation from nominal allocations will only be possible if changes are consistent with the requirement to accommodate the full NPOESS payload suite of instruments on a spacecraft which can be placed in a nominal 833 Km orbit by an EELV-class launch vehicle.

3.2.4.0.1 Mass

SRDC3.2.4.0.1-1
The mass of the complete CMIS sensor (including all subsystems, deployment mechanisms, mounting hardware, cabling, etc.) shall be less than or equal to 178 kilograms (TBR).

3.2.4.0.2 Dimensions

SRDC3.2.4.0.2-1
The CMIS notional baseline consists of an antenna and a rotating electronics canister. The CMIS shall be less than or equal to the following constraints (TBR):

Antenna Subassembly: 220 centimeters largest stowed dimension (TBR)

Electronics Subassembly: 46 centimeters x 46 centimeters x 55 centimeters (x,y,z)(TBR)

Additional subassemblies mounted internally to the spacecraft, or separately on the spacecraft surface, are (TBR)

3.2.4.0.3 Power

SRDC3.2.4.0.3-1
The power consumption of the CMIS sensor shall be less than or equal to 208 Watts (TBR).

3.2.4.0.4 Data Rate

SRDC3.2.4.0.4-1
The data rate of the CMIS sensor shall be compatible with the following constraints:

a) Stored Mission Data Rate: 80 kilobits per second (TBR) (see Note 1),
b) Real Time Data Rate Number 1: 80 kilobits per second (TBR) (see Note 1)
c) Real Time Data Rate Number 2: 20 kilobits per second (TBR) (see Note 2)

Note 1: 2:1 Data Compression Allowed
Note 2: 8:1 Data Compression Allowed

3.2.4.0.5 Sensor Spacecraft Location (TBR)

The CMIS notional baseline provides for the CMIS to be mounted on the zenith surface of the NPOESS spacecraft in order to prevent intrusions into the fields of view of other sensors. Alternative mounting locations will be considered by the NPOESS Program, but will not be approved until satisfactory accommodation of other sensors on the spacecraft has been demonstrated.

3.2.4.1 Mass Properties

SRDX3.2.4.1-1
The mass properties of each sensor shall conform to performance, stability, and control requirements of the Launch Vehicle (LV) and the Space Segment

3.2.4.1.1 Sensor Mass Documentation

SRDX3.2.4.1.1-1
The sensor contractor shall provide the mass of the sensor to the spacecraft contractor for documentation in the ICD.

SRDX3.2.4.1.1-2
The mass of the sensor shall be measured to +/- 0.1 kg.

3.2.4.1.2 Sensor Mass Variability Documentation

SRDX3.2.4.1.2-1
Sensor mass expulsion rates and substances, if any, shall be provided to the spacecraft contractor for documentation in the ICD.

3.2.4.1.3 Center of Mass

3.2.4.1.3.1 Center of Mass Allocation

SRDX3.2.4.1.3.1-1
Sensors shall be designed, where practical, to place the center of gravity location as near to the interface plane as possible unless excessive uncompensated momentum precludes this (sometimes the c.g. should be as close to a gimbal axis as possible to reduce uncompensated momentum).

SRDX3.2.4.1.3.1-2
The location of the sensor center of mass shall be provided using coordinates based on the spacecraft axes.

3.2.4.1.3.2 Center of Mass Measurement and Documentation

SRDX3.2.1.1.3.2-1
The launch and on-orbit center of mass of each sensor subsystem shall be measured and reported to +/- 5 mm, referenced to the sensor coordinate axes as documented in the ICD. Very heavy sensors may require a tighter tolerance.

3.2.4.1.4 Moments of Inertia

3.2.4.1.4.1 Moments of Inertia Measurement

SRDX3.2.4.1.4.1-1
The moments of inertia shall be defined using coordinates based on the spacecraft axes but passing through the sensor center of mass.

3.2.4.1.4.2 Moments of Inertia Accuracy

SRDX3.2.4.1.4.2-1
Moments of inertia values shall be accurate to within +/-10% (TBR)

3.2.4.1.4.3 Moments of Inertia Documentation

SRDX3.2.4.1.4.3-1
The moments of inertia of each separately mounted subsystem of the sensor shall be provided to the spacecraft contractor for documentation in the ICD, referenced to the sensor coordinate axes.

3.2.4.1.4.4 Moments of Inertia Variation Documentation

SRDX3.2.4.1.4.4-1
If the sensor contains movable masses, expendable masses, or deployables, the respective moments of inertia variations shall be provided to the spacecraft contractor for documentation in the ICD.

3.2.4.2 Dimensions

SRDX3.2.4.2-1
All documents shall provide units in metric.

SRDX3.2.4.2-2
All interfaces shall be specified in the international system of units, System Internationale (SI), unless design heritage precludes this.

SRDX3.2.4.2-3
Dimensioning shall be in the as-designed units and identified when other than SI.

SRDX3.2.4.2-4
The design of the sensor shall meet the dimensional envelope constraints under a combination of static, dynamic, and thermal conditions encountered during factory assembly, system test, transportation and handling, launch, deployment, and on-orbit operations.

3.2.4.2.1 Physical Interface

3.2.4.2.1.1 Stowed and Critical Clearances

The spacecraft contractor is responsible for defining available sensor volume and making sure the spacecraft fits within the dynamic envelope of launch vehicle's fairing. This is controlled with the spacecraft to launch vehicle Interface Control Document (ICD). Both the spacecraft contractor and the sensor contractor must work together to insure that the stowed, deploying, and final deployed positions of the sensor will clear all obstacles including obstacles on the spacecraft, other sensors, and the launch vehicle. If the sensor is to be deployed, all obstacles must be cleared in the stowed, deploying, and final deployed positions. If the sensor has moving assemblies, all obstacles must be cleared within the region of motion.
As a baseline, a 2.5 cm clearance between the sensor and surrounding structure will be maintained.
A critical clearance analysis will be conducted to identify areas where the 2.5 cm clearance rule may be violated, accounting for miscellaneous support hardware such as wire bundles and thermal blankets, deflections due to launch loads, launch vibrations, 1-g sag, thermal distortions, and misalignments, with all identified areas tracked in a critical clearance document.

3.2.4.2.1.1.1 Sensor Envelope Documentation

SRDX3.2.4.1.1.1-1
The sensor contractor shall provide to the spacecraft contractor information on the sensor subsystem envelope (including thermal blankets) for documentation in the ICD. Documentation is to be in the form of engineering drawings with a set of "not to exceed" dimensions.

3.2.4.2.1.2 Mounting Provisions

3.2.4.2.1.2.1 Mounting Method

The mounting method is to accommodate manufacturing tolerance, structural, and thermal distortions.

SRDX3.2.4.2.1.2.1 -1
The sensor contractor shall comply with the mounting specification in the ICD.

3.2.4.2.1.2.2 Mounting Interface

3.2.4.2.1.2.2.1 Mounting Interface Documentation

The spacecraft mounting interface requirements for each sensor subsystem shall be delivered to the spacecraft contractor for documentation in the ICD.

3.2.4.2.1.2.2.2 Mounting Hole Coordinates and Dimensions

SRDX3.2.4.2.1.2.2.2-1
The sensor contractor shall comply with the coordinates and dimensions of the holes for mounting hardware as specified at the mechanical interface and defined in the ICD.

3.2.4.2.1.2.3 Drill Templates

3.2.4.2.1.2.3.1 Drill Template Usage

SRDX3.2.4.2.1.2.3.1-1
If drill templates are used for simple planar interfaces, then sensor equipment, spacecraft, and test fixture interfaces shall be drilled using templates.

3.2.4.2.1.2.3.2 Drill Template Fabrication Requirements

The drill template fabrication and functional requirements (e.g. material, use of inserts, etc.) are to be provided by the sensor contractor.

3.2.4.2.1.2.3.3 Drill Template Provider

SRDX3.2.4.2.1.2.3.3-1
The sensor contractor shall provide the spacecraft contractor with the drill template containing appropriate alignment and location reference information.

3.2.4.2.1.2.4 Mounting Hardware

3.2.4.2.1.2.4.1 Mounting Hardware Provider

The spacecraft contractor is to provide all sensor mounting hardware including secondary structures.

3.2.4.2.1.2.4.2 Mounting Hardware Documentation

Sensor mounting hardware is to be defined and documented in the ICD.

3.2.4.2.1.2.4.3 Mounting Surface Requirements

Finish and flatness requirements for the mounting surfaces are to be specified by the spacecraft contractor and documented in the ICD.

3.2.4.2.1.2.5 Mounting Location and Documentation

SRDX3.2.4.2.1.2.5-1
The sensor contractor shall support the spacecraft contractor in determining the location of the sensor on the spacecraft.

SRDX3.2.4.2.1.2.5-2
The sensor contractor shall provide necessary mounting information to the spacecraft contractor for documentation in the ICD.

3.2.4.2.1.3 Alignment

3.2.4.2.1.3.1 Alignment Responsibilities

SRDX3.2.4.2.1.3.1-1
The sensor contractor shall be responsible for measuring the alignment angles between the sensor boresight (line of sight), if applicable, and the sensor alignment reference.
The spacecraft contractor is responsible for aligning the sensor alignment reference to the spacecraft attitude reference.

3.2.4.2.1.3.2 Alignment References

SRDX3.2.4.1.3.2-1
The sensor contractor shall provide a sensor alignment reference.

SRDX3.2.4.1.3.2-2
The sensor alignment reference shall be viewable from two orthogonal directions.

3.2.4.2.1.3.3 Alignment Control

The spacecraft contractor is to control the alignment of the sensor alignment reference with respect to the spacecraft attitude reference to within values specified by the sensor contractor.

3.2.4.2.1.3.4 Alignment Knowledge

3.2.4.2.1.3.4.1 Measurement Uncertainty

The spacecraft contractor is to measure the alignment between the sensor alignment reference and the spacecraft attitude reference. The RMS uncertainty in the alignment knowledge is to be less than 25 arcsec per axis. This uncertainty is to include (if applicable), but not be limited to, measurement uncertainties, alignment shifts due to vibration environments in both ground processing and launch, uncompensated gravity effects, hygroscopic effects of composite materials, and component removal and replacement.

3.2.4.2.1.3.4.2 Structural Thermal Distortion Uncertainty

The spacecraft contractor is to limit the rms uncertainty in the alignment between the sensor alignment reference and spacecraft attitude reference caused by structural thermal distortion due to the on-orbit thermal environment to be less than 10 arcsec per axis.

3.2.4.2.1.3.5   Spacecraft Attitude Reference

3.2.4.2.1.3.5.1 Attitude Reference Knowledge

The spacecraft is to supply a three-axis attitude of the spacecraft attitude reference for ground processing. The supplied attitude will be time-tagged and possess an angular rms accuracy per axis of 10 arcsec over a bandwidth of DC to 10 Hz.

3.2.4.2.1.3.5.2 High Frequency Attitude Reference Errors

The rms of all components of the attitude error of the spacecraft attitude reference with a frequency greater than 10 Hz will be less than 5 arcsec per axis.

3.2.4.2.1.3.5.3 Attitude Reference Control

The rms of the attitude reference control error over a bandwidth of DC to 10 Hz is to be less than 0.01 deg per axis.

3.2.4.2.1.3.5.4 Attitude Reference Rate Error

The rate error of the attitude reference frame is to be less than 0.03 deg/sec during all mission data collection periods.

3.2.4.2.1.3.6 Ephemeris Knowledge

The spacecraft will provide a spacecraft ephemeris estimate with an rms uncertainty of 25/25/25 meters for radial/in-track/cross-track components.

3.2.4.2.1.4 Structural Support

The spacecraft is to provide structural support for the sensor such that the loads transmitted across the interface into the sensor do not exceed interface limit loads to be determined by the spacecraft contractor.

SRDX3.2.4.2.1.4-1
The sensor and interface equipment shall be designed to meet the design load factors determined by launch vehicle acceleration levels.

3.2.4.2.1.5 Sensor Structural Dynamics

For a deployable, the spacecraft contractor is to specify a deployed frequency such that the sensor will not saturate the spacecraft's control authority.

SRDX3.2.4.2.1.5-1
When the sensor is in its launch-locked configuration, the fundamental natural frequency of the sensor shall be *50 Hz or greater,* axial and lateral.

SRDX3.2.4.2.1.5-2
The sensor contractor shall ensure that the sensor dynamic characteristics and control capability (e.g., a gimbaled sensor) will meet the requirements specified for the deployed frequency.

SRDX3.2.4.2.1.5-3
The lowest natural frequency for a deployed sensor shall be greater than 6 Hz (TBR).

3.2.4.3 Power

3.2.4.3.1 Sensor Internal Power

SRDX3.2.4.3.1-1
Primary power distribution to power components shall be compatible with system and subsystem EMC performance requirements.

SRDX3.2.4.3.1-2
Secondary power distribution to power components shall be compatible with system and subsystem EMC performance requirements.

3.2.4.3.1.1 Peak Power TBD

3.2.4.3.1.2 Power Cycle TBD

3.2.4.3.1.3 On-orbit Power TBD

3.2.4.3.1.4 Launch Power TBD

3.2.4.3.1.5 End-of-life Power TBD

3.2.4.3.2 Sensor External Power

SRDX3.2.4.3.2-1
Sensor Suites shall be designed to operate from a 28 +/- 6volt dc (TBR) power subsystem.

3.2.4.3.3 Electrical Power Interface Requirements

3.2.4.3.3.1 Electrical Interfaces

SRDX3.2.4.3.3.1-1
The electrical interfaces (Figure 3.2.4.3.3.1) shall include the following:

a. Operational Power Interface
b. Survival Heater Power Bus
c. Pulse Command Interface
d. High-rate Data Bus
e. Command Telemetry and Low-rate Data Bus
f. Grounding Interface
g. Test Point Interface

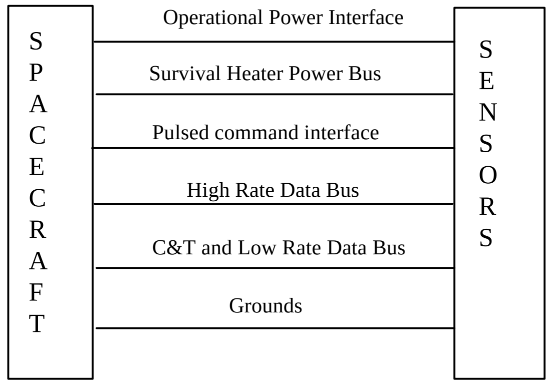


Figure 3.2.4.3.3.1. Spacecraft-Sensor Electrical Interfaces

3.2.4.3.3.1.2 Voltage Ripple

SRDX3.2.4.3.3.1.2-1
The power source-generated and load-induced ripple, including repetitive spikes, shall not exceed 1.0 volts peak-to-peak as measured over the bandwidth of 30 Hz to 1.0 kHz, and 0.5 volts peak-to-peak from 1.0 kHz to 10 MHz when the power system is delivering the maximum rated current into loads.

3.2.4.3.3.1.3 Reflected Ripple

SRDX3.2.4.3.3.1.3-1
Loads shall not produce reflected ripple greater than the limits of MIL-STD-461D, part 3, CEO1 and CEO3. CEO1 maximum levels apply to loads that are 15 amps/450 watts and greater.

SRDX3.2.4.3.3.1.3-2
CEO1 maximum emissions shall be reduced by 20 dB for each 20 amps reduction in current.

3.2.4.3.3.1.4 Transients

SRDX3.2.4.3.3.1.4-1
Positive and negative voltage surges shall decay to within steady state limits in less than 5 and 100 milliseconds, respectively.

SRDX3.2.4.3.3.1.4-2
All sensor components shall remain undamaged when subjected to step changes of the input voltage from 0% to 140% and from 120% to 0% of the nominal load voltage (28 volts). The step changes, exclusive of spikes, are the instantaneous surge amplitudes produced by load switching and the clearing of faults on the space-vehicle power bus.

SRDX3.2.4.3.3.1.4-3
With step changes from 0% to 100% of the nominal load voltage, the instantaneous inrush current shall not exceed 4-times the maximum average input current.

3.2.4.3.3.1.5 Undervoltage Protection

The spacecraft is to be able to remove bus power to all sensors if the bus voltage drops below 22 volts. Control heaters are to be turned off during these occurrences. This does not apply to survival heaters.

3.2.4.3.3.1.6 Spacecraft Power Bus Impedance

The spacecraft bus impedance at the interface looking back at the source is to be less than 100 milli-ohms resistive and 5 micro-henries inductive.

3.2.4.3.3.2 Electrical Current

Three types of power are to be supplied to each sensor.

3.2.4.3.3.2.1 Survival Heater Power

SRDX3.2.4.3.3.2.1-1
Direct bus connection shall be through a 5 ampere spacecraft fuse for 50 watt heater load maximum (TBR).

SRDX3.2.4.3.3.2.1-2
Thermal analysis shall be done to verify the adequacy of a 5 amp survival heater.

SRDX3.2.4.3.3.2.1-3
The sensor shall have two series thermostats to ensure fault-tolerant usage of this bus.

3.2.4.3.3.2.2 Control Heater Power

Bus connection is to be made through a 5 ampere fuse and relay switch in the spacecraft for a 50 watt heater load maximum (TBR).

3.2.4.3.3.2.3 Sensor Power

Two supply circuits types are to be provided:

a) A 0-5 ampere steady-state power connection is made through a 15 ampere fuse and relay switch in the spacecraft. Peak inrush at initial power application is 10 times steady-state. Peak inrush at sensor power-on is 4 times steady-state.
b) A 5-20 ampere steady-state power connection is made through a 60 ampere fuse and relay switch in the spacecraft. Peak inrush at initial power application is 4 times steady-state. Peak inrush at sensor power-on is 4 times steady-state.

3.2.4.3.3.3 Grounds, Returns, and References

3.2.4.3.3.3.1 Grounding

The primary power source (battery, power converter) is to be chassis grounded at only one point to avoid large structure current flow which might interfere with other spacecraft loads. The method used to reference the signal back to the secondary power return is dependent on the signal type. The goal is to minimize the voltage drop across the return.

SRDX3.2.4.3.3.3.1-1
The sensors shall have a single point ground.

SRDX3.2.4.3.3.3.1-2
Secondary power and signal returns shall be isolated from the primary power return by not less than 1 Meg-ohm when the sensor is disconnected from the interface/spacecraft and when measured at the sensor input. The secondary grounds may be grounded to structure if the local structure is conductive.

SRDX3.2.4.3.3.3.1-3
The impedance between the sensor and spacecraft single point ground shall be less than 10 Meg-ohms. This impedance may need to be smaller if the expected voltage drop and current flow exceed either the required error in the sensor reference or the radiated emission requirements.

3.2.4.3.3.4 Power Harnesses

3.2.4.3.3.4.1 Electrical Connectors

The spacecraft contractor is to provide all spacecraft interface mating connectors.

SRDX3.2.4.3.3.4.1-1
For the standard electrical connector, separate D connectors, such as Cannon NM-K52 (rated at 5 amps, derated below 5 amps), military D subminiature non-magnetic/no-outgas connectors as described in MIL-C-24308, or Positronic SAD Series connector (rated at 7.5 amp, derated below 7.5 amps for use when load requires 5 amps) and Kem connector accessories shall be used for primary power, survival heater power, and analog thermistor returns (TBR).

SRDX3.2.4.3.3.4.1-2
The contractor shall derate electrical connectors using MIL-STD-1547 as a guide.

SRDX3.2.4.3.3.4.1-3
All interface circuits shall be categorized by signal type using DOD-W-83575 as a guide..

SRDX3.2.4.3.3.4.1-4
Primary and redundant connectors shall be differentiated by clearly marking all boxes and cables. Interface requirements for sensor electrical connectors are as follows: (TBR).

3.2.4.3.3.4.2 Wiring

SRDX3.2.4.3.3.4.2-1
All power harnesses shall be #20 AWG, with 150 °C insulation. (TBR).

SRDX3.2.4.3.3.4.2-2
Twisted pairs shall be used to reduce magnetic contribution.

SRDX3.2.4.3.3.4.2-3
The wire current-handling capability shall be calculated at the ambient temperature. (TBR).

SRDX3.2.4.3.3.4.2-4
The sensor contractor shall determine the proper wire insulation requirements for any wire directly exposed to the space environment.

3.2.4.3.3.4.3 Fault Isolation

Fault isolation is to be included on the spacecraft side of the interface. The spacecraft is to be capable of removing any load in excess of 30 watts. The fault isolation is to either open the circuit to remove the load and short circuit from the spacecraft, or limit the current to the maximum specified load current. Fuses and circuit breakers are to be sized to protect wire between the bus and the sensor. The wire is to be sized to the maximum load. The fuses are to be derated by a factor of three.

3.2.4.3.3.5 Signal Cabling

SRDX3.2.4.3.3.5-1
Data and telemetry signals shall be segregated and routed from any power circuitry via a separate connector.

SRDX3.2.4.3.3.5-2
The voltage drop across any secondary return shall be less than the maximum allowable noise on the signal circuit reference.

SRDX3.2.4.3.3.5-3
Digital or analog cross talk between any two signal lines in data connectors shall be no greater than -20 dB at the maximum data rate.

3.2.4.4 Survivability

The NPOESS System Survivability requirements are contained in Appendix B.

3.2.4.5 Endurance (TBR)

SRDX3.2.4.5-1
The on-orbit design life of the sensor, shall be no less than 7 years.

SRDX3.2.4.5-2
The design of the sensor shall be such that sensor storage, under controlled conditions, may be planned for as long as 8 years, including up to 3 years for intermittent testing.

SRDX3.2.4.5-3
The design service life of the sensor shall be at least 15 years. This includes the time allowed for test, storage, prelaunch checkout, launch and injection, on-orbit, recovery, and contingency time.

3.2.4.6 Protective Coatings and Finishes

SRDX3.2.4.6-1
The finishes used shall ensure that completed devices are resistant to degradation caused by environmental conditions and galvanic action.

SRDX3.2.4.6-2
The sensors shall have special coatings for protection of surfaces against deterioration in space environments.

SRDX3.2.4.6-3
The sensors shall have special coatings for electrostatic discharge suppression in all environments.

SRDX3.2.4.6-4
The sensors shall not use cadmium or zinc platings.

SRD 3.2.4.6-5
Pure tin or tin alloy (>98% Sn) plating shall not be used on electrical devices and hardware for launch and space vehicles. The guiding document for this prohibition is MIL-STD-1547B, "Electronic Parts, Materials, and Processes for Space and Launch Vehicles."

SRDX3.2.4.6-6
Both metallic and insulating surfaces in electronic boxes, such as printed wiring assemblies, where contamination could cause electrical malfunction shall be conformally coated unless otherwise insulated or hermetically sealed.

SRDX3.2.4.6-7
This shall apply to electrical components in sensors and their associated ground equipment. MIL-I-46058, or equivalent can be used in selection of conformal coatings and their thicknesses.

SRDX3.2.4.6-8
Unjacketed flexible shielded cable and ground straps shall be specifically excluded from this conformal coating requirement.

SRDX3.2.4.6-9
Certain components will suffer significant performance degradation if conformally coated. In these situations, non-use of conformal coatings on electrical components and hardware shall be supported by a thorough analysis and be specifically approved by the government on a case by case basis.

SRDX3.2.4.6-10
There shall be no destructive corrosion of the completed devices if exposed to moderately humid or mildly corrosive environments during manufacture or handling.

3.2.4.7 Thermal

3.2.4.7.1 General

SRDX3.2.4.7.1-1
All interface requirements specified in Section 3.2.4.7 shall be met at the mechanical interface.

The sensor thermal design shall provide for:

SRDX3.2.4.7.1-2
a. Maintaining the sensor within operating and survival temperature limits,

SRDX3.2.4.7.1-3
b. Maintaining the sensor at the minimum turn-on temperature via survival power,

SRDX3.2.4.7.1-4
c. Minimizing thermal gradients within the sensor,

SRDX3.2.4.7.1-5
d. Thermal decoupling of the sensor from the spacecraft.

3.2.4.7.2 Thermal Isolation to Spacecraft

The spacecraft is not be used as a heat source or sink.

SRDX3.2.4.7.2-1
The sensor shall be designed to maximize thermal isolation.

SRDX3.2.4.7.2-2
Sensor components shall be designed to maintain the sensor within its allowable temperature limits.

SRDX3.2.4.7.2-3
The thermal control unit shall be mounted on the sensor, where possible, or insulated in order to minimize thermal load to the spacecraft.

3.2.4.7.3 Heat Transfer

3.2.4.7.3.1 Heat Transfer

SRDX3.2.4.7.3.1-1
The heat transfer between the sensor (or interface plate) and the spacecraft shall not exceed 10.0 (TBR)watts maximum. Sensors with high power dissipation near the interface, or configuration requirements that do not lend themselves to thermal-isolation methods, require the contractor to develop mission sensor-specific heat-transfer rates.

SRDX3.2.4.7.3.1-2
For design purposes, the 10.0 watts heat transfer shall be applied in a worst-case scenario.

3.2.4.7.3.2 Radiation

The spacecraft contractor is to provide the radiative loads to the sensor.

SRDX3.2.4.7.3.2-1
Incident radiation between the spacecraft and a sensor on any given surface shall be minimized.

SRDX3.2.4.7.3.2-2
The environmental fluxes, as shown in Table 3.2.4.7.3.2 below, shall add solar, albedo and earth IR hot fluxes for the hot case analysis and cold fluxes for the cold case analysis.

Table 3.2.4.7.3.2 Worse-Case Hot and Cold Environments

	Hot Case		Cold Case	
	BTU/hr-ft^2	W/m^2	BTU/hr-ft^2	W/m^2
Solar Radiation	444	1400	415	1308
Albedo	172	542	86	271
Earth IR Radiation	83	262	60	189

3.2.4.7.4 Temperature Ranges

3.2.4.7.4.1 Spacecraft Temperature Range

SRDX3.2.4.7.4.1-1
For planning and preliminary design purposes, the interface temperature of the spacecraft is to be initially assumed to range from:

a. +5 °C (TBR) to +40 °C during normal operations
b. -20 °C to +50 °C during survival modes

3.2.4.7.4.2 Thermal Uncertainty Margins

SRDX3.2.4.7.4.2-1
Thermal uncertainty margins used during the design and validation shall be applied to determine acceptance ranges in accordance with MIL-STD-1540C.
If heaters are employed, 25% heater control authority can be used in place of 11 °C uncertainty margin.
Protoqualification ranges can be calculated by adding additional margins ±5 °C .

3.2.4.7.4.3 Sensor Temperature Range

SRDX3.2.4.7.4.3-1
Temperature limits for sensor components during ground test and orbital operations shall be provided to the spacecraft contractor for documentation in the ICD.

SRDX3.2.4.7.4.3-2
Operating, non-operating, survival and turn-on temperature requirements shall be provided.

3.2.4.7.5 Temperature Monitoring

3.2.4.7.5.1 Mechanical Mounting Interface Temperature Monitoring

The spacecraft is to monitor and report in the spacecraft telemetry the temperature of the spacecraft at the sensor mechanical mounting interfaces.

3.2.4.7.5.2 Sensor Temperature Monitoring

All critical sensor temperatures are to be measured and reported in the health and status telemetry data.

3.2.4.7.5.3 Temperature Sensor Locations

SRDX3.2.4.7.5.3-1
The location of all sensor and mounting interface temperature sensors shall be provided to the spacecraft contractor for documentation in the ICD.

3.2.4.7.6 Thermal Control Design

SRDX3.2.4.7.6-1
The sensor thermal-control subsystem shall be designed to minimize heater power requirements.

SRDX3.2.4.7.6-2
Use of passive thermal control techniques shall be maximized.

3.2.4.7.6.1 Thermal Control Hardware

SRDX3.2.4.7.6.1-1
The sensor contractor shall provide to the spacecraft contractor information on sensor provided thermal control hardware for documentation in the ICD. The responsibility for providing the thermal control hardware is defined in Table 3.2.4.7.6.1.

Table 3.2.4.7.6.1. Thermal Control Hardware Responsibility

Hardware	Responsibility
Survival Heaters	Sensor Provider
Sensor, Thermal Control Hardware, including blankets, louvers, and heat pipes	Sensor Provider
Thermal insulation Blankets to Interface between the Sensor Thermal Blankets and the Spacecraft Thermal Blankets	Spacecraft Provider

3.2.4.7.6.2 Survival Heater Design

Electrical power for survival heaters is to be provided by the host spacecraft to accommodate at least two strings, a primary and secondary string, of sensor survival heaters.

SRDX3.2.4.7.6.2-1
Sensors shall use survival heaters to maintain temperature at the safe turn-on level.

SRDX3.2.4.7.6.2-2
Operational heaters shall be controlled by the sensor.

SRDX3.2.4.7.6.2-3
Survival heater circuits shall not exceed 0.5 (TBR) amperes per string.

SRDX3.2.4.7.6.2-4
Survival heater circuits shall be provided directly to thermostatically controlled heaters on the sensor side.

SRDX3.2.4.7.6.2-5
Survival heaters shall be capable of operation when the sensor power is off.

SRDX3.2.4.7.6.2-6
The interface shall also have the capability to accommodate up to five analog thermistors (3 kohms at 25 °C) per interface. These analog lines are separate and in addition to any state of health (SOH) input being transmitted over the serial data bus interface and are intended to provide insight during periods when the sensor power is off; therefore, excitation of thermistors is to be provided by the spacecraft.
When the sensor is unpowered, the survival heaters is to be controlled by the spacecraft through the sensor thermistor inputs.

SRDX3.2.4.7.6.2-7
Redundant thermostats shall be used.

3.2.4.7.6.3 Multilayer Insulation

The spacecraft contractor is to approve the Multilayer Insulation (MLI) selection in the Parts, Materials and Processes Control Board (PMPCB) review process.

SRDX3.2.4.7.6.3-1
MLI used in thermal control design shall have the following provisions: venting, interfacing with spacecraft thermal control surfaces, and electrical grounding to prevent Electro-Static Discharge (ESD).

3.2.4.7.6.4 Other Considerations

SRDX3.2.4.7.6.4-1
Thermal control surfaces shall be cleanable to visibly clean or better.

SRDX3.2.4.7.6.4-2
Any sealed or closed system such as heat pipes, thermal control enclosures or fluid loops shall be analyzed to demonstrate that no safety hazard exists.

3.2.4.8 Data and Command Interface

3.2.4.8.1 General Command Electrical

3.2.4.8.1.1 Interface Conductors

SRDX3.2.4.8.1.1-1
All signal interfaces shall use shielded conductors. Conductors may include, but are not limited to, twisted pair, coaxial, twinaxial, dual coaxial types, and fiber optics.

3.2.4.8.1.2 Interface Circuitry Isolation

SRDX3.2.4.8.1.2-1
The sensor shall maintain electrical isolation of greater than 100 kohm between the primary and redundant interface circuitry within the sensor front end.

3.2.4.8.1.3 Interface Fault Tolerance

SRDX3.2.4.8.1.3-1
The sensor and spacecraft bus shall be tolerant of a single fault occurring in a signal interface circuit on either side of the interface.

3.2.4.8.1.4 Power Bus

The characteristics of the power bus with respect to power return will be as specified in the Electromagnetic Compatibility (EMC) Control Plan.

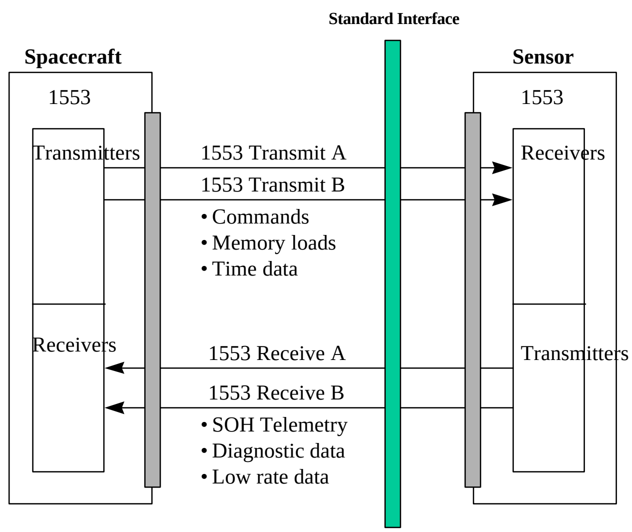
3.2.4.8.2 Command and Telemetry Data Bus Requirements

3.2.4.8.2.1 Bus Functions

SRDX3.2.4.8.2.1-1
The Command and Telemetry Data bus shall be utilized as shown below and in Figure 3.2.4.8.2 .

a) Spacecraft to sensor/remote terminal transfers consisting of:
   - real time commands
   - stored commands
   - memory loads
   - frame sync and time code data

b) Sensor/remote terminal to spacecraft transfers consisting of:
   - sensor health and status telemetry
   - sensor diagnostic data
   - low rate science data



Note: MIL-STD-1773 is being considered as an option.

Figure 3.2.4.8.2. Data Transfer Interface

3.2.4.8.2.2 Bus Type

SRDX3.2.4.8.2.2.-1
The Command and Telemetry (C&T) Data bus shall be a dual standby redundant data bus that complies in accordance with the requirements of MIL-STD-1553B, Notice 2, all sections.

SRDX3.2.4.8.2.2-2
Additional requirements shall be specified wherever necessary to select MIL-STD-1553 options and to eliminate ambiguities. MIL-STD-1773 is being considered as an option for the C&T and Low-Rate Data Bus.

3.2.4.8.2.3 Bus Configuration

The spacecraft C&DH is to perform the Bus Controller (BC) function for the 1553 data bus to send data to and collect data from the sensors/subsystems.

SRDX3.2.4.8.2.3-1
Sensors shall interface with the 1553 data bus via a Remote Terminal (RT) as shown in Figure 3.2.4.8.2.3.

SRDX3.2.4.8.2.3-2
Those sensors without an internal 1553 interface shall interface to the data bus via a Remote Terminal (RT).

SRDX3.2.4.8.2.3-3
The sensors shall interface to the dual standby redundant data bus via dual redundant RT(s) to receive data from and send data to the spacecraft upon request.

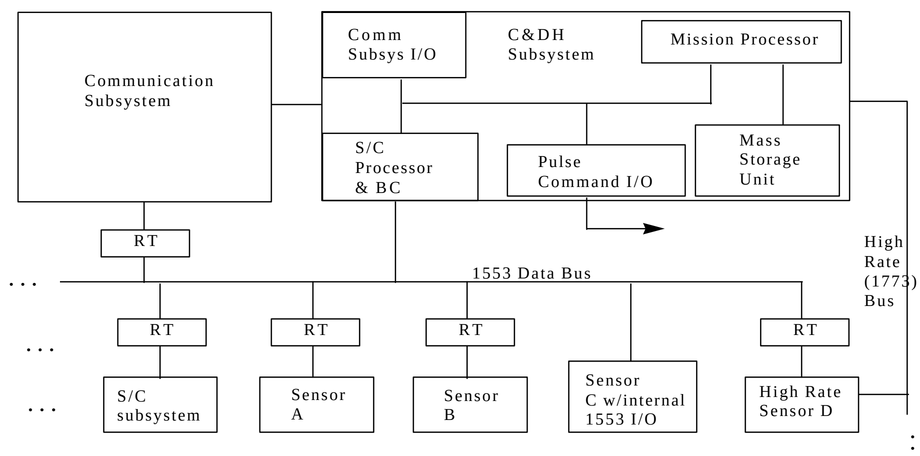


Figure 3.2.4.8.2.3. Command and Data Handling Interface Topology

3.2.4.8.3 General Bus Requirements

3.2.4.8.3.1 Electrical Interface

SRDX3.2.4.8.3.1-1
The electrical interface of the C&T Data bus shall comply with the requirements of MIL-STD-1553B, Notice 2, all sections.

SRDX3.2.4.8.3.1-2
Each electrical interface between the sensor/RT and the data bus shall be dual redundant.

SRDX3.2.4.8.3.1-3
Each RT shall be individually transformer coupled to both the primary and the redundant data buses.

SRDX3.2.4.8.3.1-4
No single failure in the data bus electrical interface circuit on either the sensor/RT side of the interface or the spacecraft data bus side of the interface shall cause the sensor to lose the capability to communicate with both the primary and the redundant data buses via each functionally distinct RT.

3.2.4.8.3.2 Data Bus Monitoring

The Bus Controller (BC) is to monitor the data bus status so that no sensor/remote terminal or data bus failure prevents the Bus Controller from maintaining data flow over the Data Bus.

3.2.4.8.4 Sensor Commands and Memory Load

3.2.4.8.4.1 Command Types

The spacecraft is to deliver the following data to the specified sensor RT-receive subaddresses by conducting single BC to RT Transfers or single RT to RT Transfers (from a spacecraft RT to an sensor RT):

SRDX3.2.4.8.4.1-1
The sensor shall be capable of accepting pulse and serial commands with the characteristics specified:

3.2.4.8.4.1.1 Pulse Command

<u>Pulse Command</u>

a. Logic 0	TBR
b. Logic 1	TBR
c. Load Capacitance	TBR
d. Pulse Width	TBR
e. Voltage Rise Time	TBR
f. Voltage Fall Time	TBR
g. Noise Immunity	TBR
h. Inductive Spike Suppression	TBR

3.2.4.8.4.1.2 Serial Command

The serial command input will consist of Not Return to Zero (NRZ) data, clock and envelope signals.

SRDX3.2.4.8.4.1.2-1
The RT to Sensor serial command transfer shall consist of a three wire interface. Characteristics of the interface are TBD.

3.2.4.8.4.2 Packetization for Commands and Memory Loads

SRDX3.2.4.8.4.2-1
Unless otherwise specified, all commands and memory loads delivered to the sensor/remote terminal shall be formatted in accordance with the CCSDS Telecommand packet defined in CCSDS 203.0-B-1.

3.2.4.8.4.3 Documentation

SRDX3.2.4.8.4.3-1
All sensor commands and memory load packet descriptions shall be delivered to the spacecraft contractor for documentation in the ICD.

3.2.4.8.4.4 Critical Commands

SRDX3.2.4.8.4.4-1
Initiation of critical or hazardous functions shall use, as a minimum, separate enable and execute commands to prevent inadvertent execution of critical commands.

3.2.4.8.4.5 Frame Sync and Time Code Data

The spacecraft is to provide frame sync and time code data signals to the sensors.
The format of the vehicle time code words is to be based on the GPS UTC time representation. On-board absolute correlation of time is to be 1 millisecond or better with a correlation to 1 microsecond as a goal. Time representation is to be transmitted over the 1553 data bus or 1773 data bus once per second and is to correspond to the time of the rising edge of the time-of-day pulse.

3.2.4.8.5 Health and Status Telemetry Data

SRDX3.2.4.8.5-1
Sensor health and status telemetry data shall include housekeeping data required for sensor status and health monitoring. Sensor health and status telemetry includes:

- Sensor mode and configuration
- Sensor temperatures
- Sensor power supply current and voltage
- Relay status, scan mirror rotation and other rotating mechanism rates
- Other telemetry data required to support sensor performance evaluation

3.2.4.8.5.1 Telemetry Diagnostic Data

During sensor anomaly resolution, the spacecraft C&DH is to have the capability to dwell on particular telemetry measurands within the selected telemetry format in support of ground diagnostic investigation of the sensor anomaly. Dwell capability is to be a ground initiated process.

3.2.4.8.6 Low Rate Science Data

Low rate science data is defined as the user mission data from the sensors identified to produce output data rates less than 100 kbps. The spacecraft C&DH is to collect the low rate science data from the respective sensors through a sequence of data transfers over the 1553 data bus.

3.2.4.8.6.1 Telemetry and Low Rate Data Packetization

SRDX3.2.4.8.6.1-1
All telemetry and low rate data shall be packetized using the CCSDS Path Protocol Data Unit format in accordance with CCSDS 701.0-B-1.

3.2.4.8.7 Data Bus Sampling Rate

The combined rate at which the spacecraft transmits commands, samples telemetry and collects low rate mission data to/from the sensors/subsystems, the maximum duration of a data transfer cycle and the minimum time gap between transfer cycles is to comply with the MIL-STD-1553, Notice 2 specification.

The bus sampling rates for each sensor are to meet the sensor service requirements.

3.2.4.9 High Rate Bus

3.2.4.9.1 Bus Functions

SRDX3.2.4.9.1-1
A redundant High Rate (Mission Data) Bus shall be utilized to transfer the High Rate Science (Mission) Data from a high rate sensor(s) to the spacecraft C&DH.

3.2.4.9.2 High Rate Data Bus Transmission Rate

A high-rate data bus is to be used for a sensor with data rates of > 100 Kbps or to a sensor suite with combined data rates of > 100 Kbps.

3.2.4.9.3 Bus Type

SRDX3.2.4.9.3-1
The high rate data bus shall be in compliance with MIL-STD-1773B. (TBR)

3.2.4.9.4 High Rate Data Packetization

SRDX3.2.4.9.4-1
All data to be transferred to the spacecraft C&DH via the high rate data bus shall be packetized using the CCSDS Path Protocol Data Unit format defined in CCSDS 701.0-B-1.

3.2.5 Sensor Quality Factors

3.2.5.1 Reliability

Reliability is defined as the probability that an item can perform its intended function for a specified interval under stated conditions.

SRDX3.2.5.1-1
Each sensor suite's reliability shall be no less than 0.86 at the end of 7 years on orbit life. (TBR).

SRDX3.2.5.1-2
The sensor suite shall be operational 24 hours per day with no on-orbit repair capability.

3.2.5.1.1 Operational Service Life

SRDX3.2.5.1.1-1
The on-orbit design life of the sensor, shall be no less than 7 years.

SRDX3.2.5.1.1-2
The design of the sensor shall be such that sensor storage, under controlled conditions, may be planned for as long as 8 years, including up to 3 years for intermittent testing.

SRDX3.2.5.1.1-3
The design service life of the sensor shall be at least 15 years. This includes the time allowed for test, storage, prelaunch checkout, launch and injection, on-orbit, recovery, and contingency time.

3.2.5.1.2 Maintainability

The sensor suite design should include maintainability features to ensure timely replacement or test of sensor subsystems or modules prior to launch.

SRDX3.2.5.1.2-1
Only remove and replace maintenance actions shall be performed on the satellite and sensors after acceptance for shipment or storage by the procuring agency.

SRDX3.2.5.1.2-2
Except for software updates, the sensor suite shall not require maintenance or repair on-orbit.

SRDX3.2.5.1.2-3
Single-point failures of the sensors shall be eliminated where practical if they cause loss or serious degradation of the sensor's on-orbit mission.

SRDX3.2.5.1.2-4
Redundancy shall be provided where practical to eliminate critical single-point failures in the sensors and to ensure that the reliability requirements are satisfied.

SRDX3.2.5.1.2-5
For instances of on orbit failure of a sensor suite component, the sensor suite shall place itself into safe mode to await further commands by the spacecraft.

SRDX3.2.5.1.2-6
The contractor shall perform failure analysis to determine failures for which automatic switchover to redundant components is appropriate.

SRDX3.2.5.1.2-7
The sensor suite shall remain in a readiness condition following integration and system performance verification so that it will be available for launch within 60 days (objective is 45 days).   The satellite and integrated sensors will support a launch event within 60 days of notification (objective is 45 days).

3.2.6 Environmental Conditions

3.2.6.1 Natural Environment Characteristics

Specification of natural environment characteristics in the presence of which the sensor must meet all other requirements

SRDX3.2.6.1-1
The sensor shall be compatible with the natural environments for their operational orbits. The following references contain specifications of the natural environment: MIL-STD-1809 (USAF): Space Environments for USAF Space Vehicles; NASA SP-8031: NASA Space Vehicle Design Criteria / Structures; NASA Tech Memorandum 100471: Orbital Debris Environments for Spacecraft Designed to Operate in Low Earth Orbit; and the Handbook of Geophysics and Space Environments.

3.2.6.1.1 Total Ionizing Dose Environment

SRDX3.2.6.1.1-1
The sensor shall be capable of meeting the proton and electron total dose levels for a 7-year mission given in Table 3.2.6.1.1 below.

SRDX3.2.6.1.1-2
Two times the total dose shall be used to provide a design margin factor of two (Note: aE+N=a x 10^N, e.g. 3.264E+06 = 3.264 x 10^6; one mil is 10^{-3} inch).

Table 3.2.6.1.1 Total Ionizing Dose Environment

SHIELDING Mils (AI)	Trapped Protons/7 Yr	Trapped Electrons/7 Yr
100	6.50 E03	1.81 E04
200	4.79 E03	2.06 E03
400	3.67 E03	6.76 E01
600	3.05 E03	4.35 E01
1000	2.25 E03	3.04 E01

3.2.6.1.2 Cosmic Ray and High Energy Proton Environment

3.2.6.1.2.1 Single Events Radiation Environment

SRDX3.2.6.1.2.1-1
The sensor shall be capable of meeting all performance requirements in the Cosmic Ray and High Energy Proton Radiation Environment specified in 3.2.6.1.2.1.1 and 3.2.6.1.2.1.2.

SRDX3.2.6.1.2.1-2
Predictions of single events (i.e. single event latch-up, single event upset and single event burn-out) induced by galactic cosmic ray ions and high energy protons shall be performed separately and the results combined.

3.2.6.1.2.1.1 Galactic Cosmic Ray Linear Energy Transfer (LET) Spectrum

The integral galactic cosmic ray linear energy transfer spectrum in (TBS) shall be used for prediction of ion-induced single events.

3.2.6.1.2.1.2 High Energy Proton Fluence

SRDX3.2.6.1.2.1.2-1
The differential proton fluence in (TBS), which consists of trapped protons and galactic cosmic ray protons shall be used for prediction of proton-induced single events in the absence of solar flares.

SRDX3.2.6.1.2.1.2-2
The differential proton fluence in (TBS), which consists of trapped protons, galactic cosmic ray protons and solar flare protons, shall be used for prediction of proton-induced single events with solar flares.

3.2.6.1.2.1.3 Peak Fluxes

SRDX3.2.6.12.2.1.3-1
The sensor shall be capable of meeting all performance requirements when exposed to trapped proton (E ≥ 5 MeV) flux of (TBS) particles/cm^{2}sec, trapped proton (E ≥ 0.5 MeV) flux of (TBS) particles/cm^{2}sec with the following estimated solar flare proton peak fluxes and associated total event integral fluences for each extremely large solar flare:

Energy (MeV)	Flux (Particles/cm^{2}sec)	Total Event Integral Fluence (Particles/cm)
>10	TBS	TBS
>30	TBS	TBS
>60	TBS	TBS
> 100	-	TBS

The total event integral fluence is accumulated within a time interval of a few hours to two days.

3.2.6.1.2.2 Displacement Damage

SRDX3.2.6.1.2.2-1
Prediction of proton-induced displacement damage (also known as the bulk damage) to Charge Coupled Device (CCD) detectors shall be based on the differential proton fluence in (TBS).

SRDX3.2.6.1.2.2-2
Where CCD detectors are used, the design shall incorporate features that minimize the effects of displacement damage.

3.2.6.2 Launch Environment

SRDX3.2.6.2-1
The sensor shall be designed to withstand a payload fairing internal pressure decay rate of 20 mb/sec.

SRDX3.2.6.2-2
The sensor shall be designed to meet the launch environment.

3.2.6.2.1 Thermal (TBS)

3.2.6.2.1.1 Temperatures

SRDX3.2.6.2.1.1-1
The worst case effective internal environment within the fairing shall not exceed that caused by the internal fairing wall temperature profiles shown in Figure 3.2.6.2.1.1, with a surface emissivity of 0.1.

SRDX3.2.6.2.1.1-2
The combination of actual temperature and emissivity values may vary but in no case shall it expose the sensor to a thermal environment greater than that specified herein more than 10% of the time nor greater than 5% (in degrees F) above the maximum stated temperature.

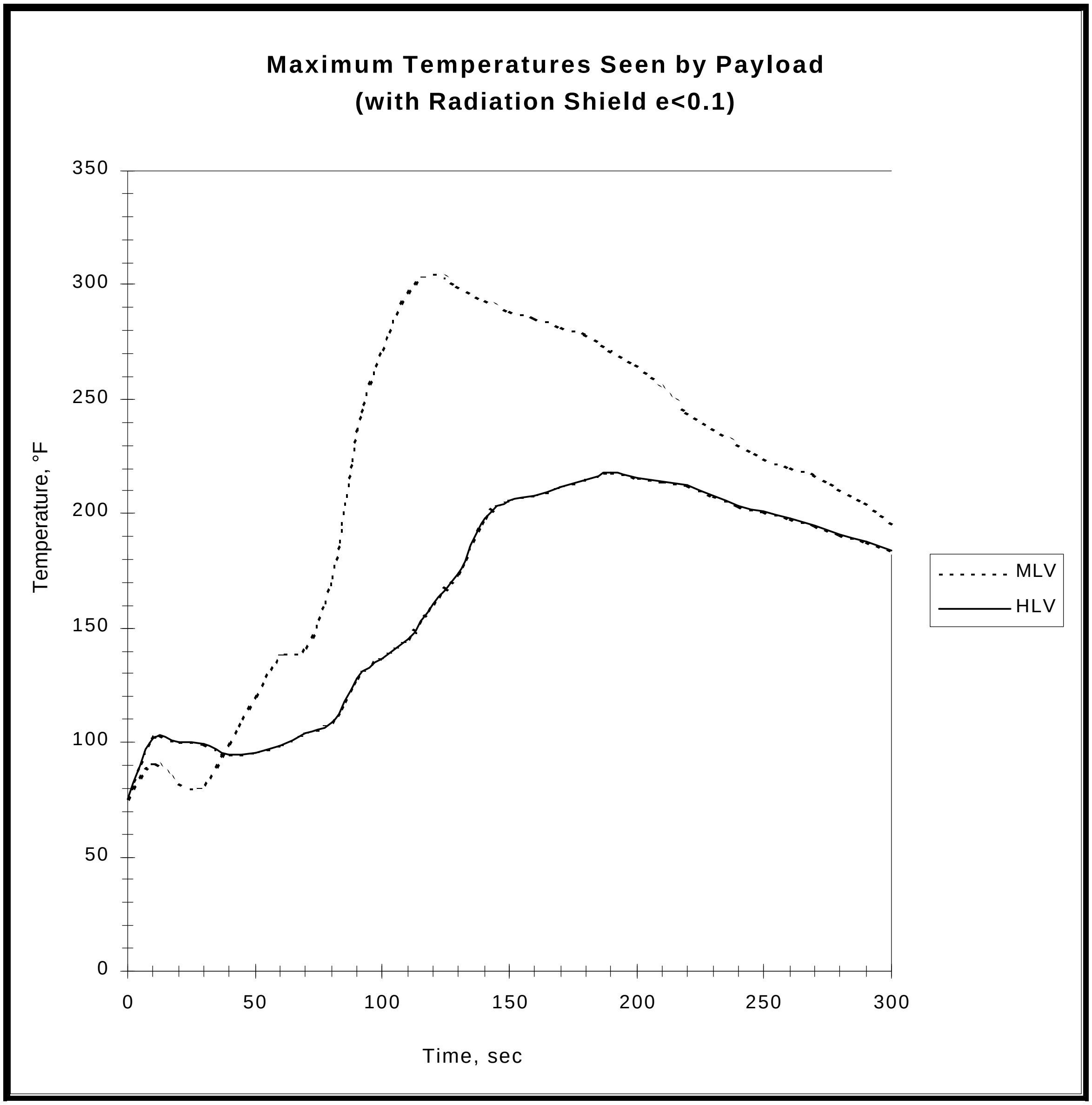


Figure 3.2.6.2.1.1 Maximum PLF Inner Temperatures

3.2.6.2.1.2 Heat Flux   (TBS)

3.2.6.2.1.3 Free Molecular Heating

SRDXX 3.2.6.2.1.3-1
The maximum instantaneous 3-sigma Free Molecular Heating on sensor surfaces perpendicular to the velocity vector at the time of fairing separation shall not exceed 0.1814 watts/cm^2 (320 Btu/hr-ft^2). Lower values may be achieved at the expense of LV performance and will be addressed on a case-by-case basis.

3.2.6.2.2 Shock (TBS)

3.2.6.2.3 Acceleration Load Factors

The quasi-static load factors for the MLV are shown in Figure 3.2.6.2.3.

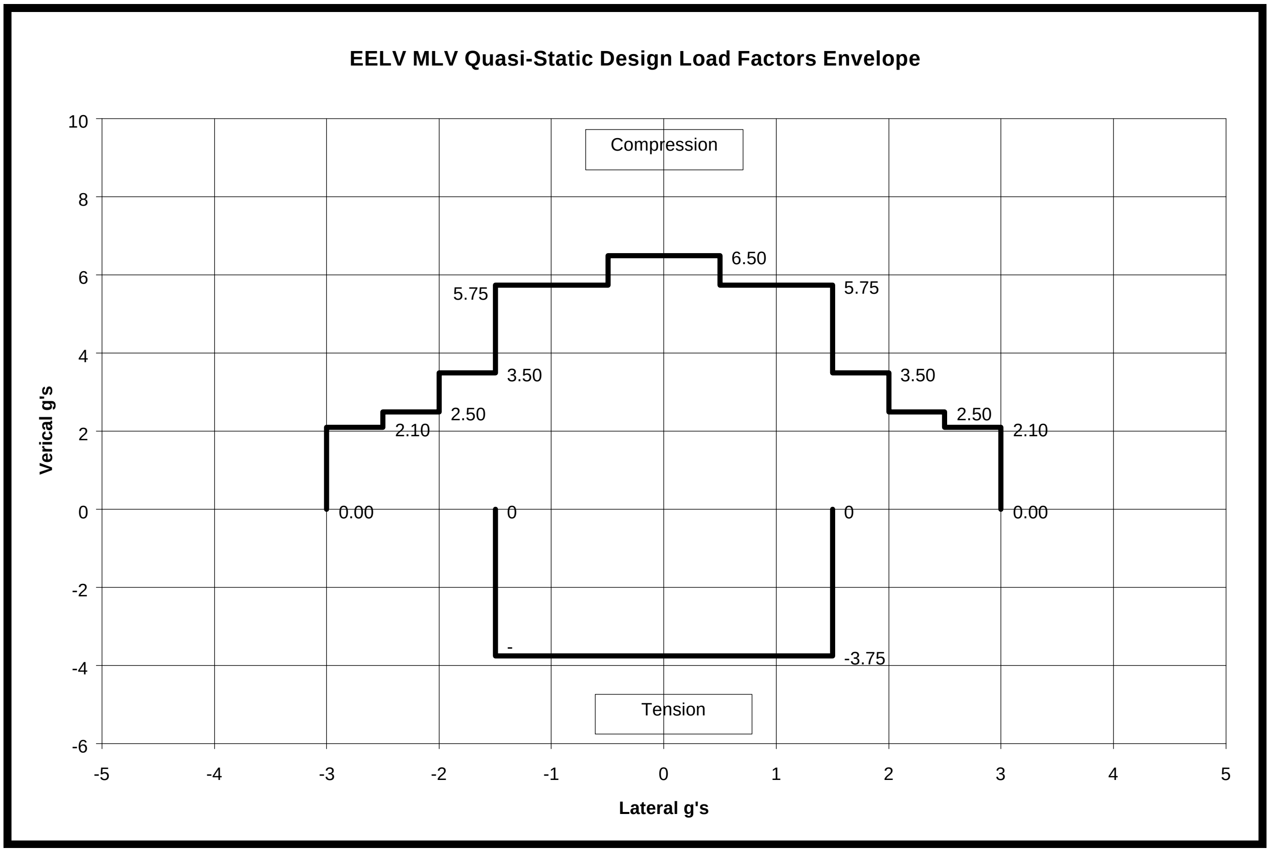


Figure 3.2.6.2.3 MLV Quasi-Static Load Factors

3.2.6.2.4 Vibration

The maximum in-flight vibration levels will be provided in the LV to Satellite ICD, but are not defined in this SRD. Sensor design should be performed using the Expendable Evolved Launch Vehicle (EELV) acoustic data (provided in the next section).

3.2.6.2.5 Acoustics

SRDX3.2.6.2.5-1
The free-field maximum expected sound pressure levels (value at 95% probability within 50% confidence), from liftoff through payload separation shall not exceed those shown in Table 3.2.6.2.5 Maximum Acoustic Levels. These levels are shown graphically in Figure 3.2.6.2.5 for the MLV. The values shown are for fill factors of less than 60%. Higher fill factors may produce higher acoustic levels. Some sensors may choose to design to lower levels provided with the optional attenuation shown for MLV.

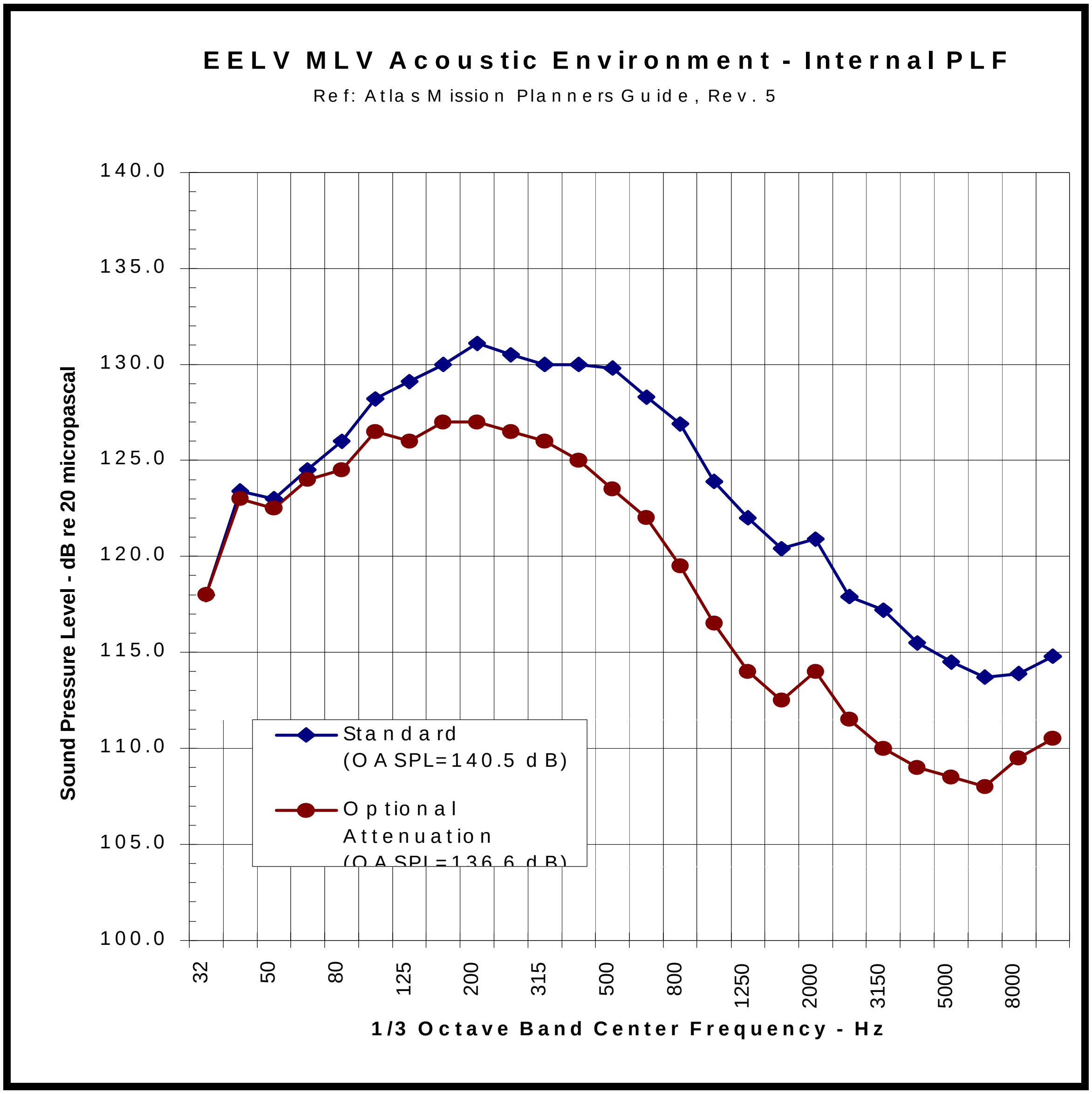


Figure 3.2.6.2.5 MLV Acoustic Levels

Table 3.2.6.2.5 Maximum Acoustic Levels

1/3 Octave Band Center Frequency (Hz)	MLV Internal PLF Sound Pressure Level (dB re 20 micropascal)	MLV Internal PLF Sound Pressure Level (dB re 20 micropascal) -with optional blanketing-
32	118.0	-
40	123.4	123.0
50	123.0	122.5
63	124.5	124.0
80	126.0	124.5
100	128.2	126.5
125	129.1	126.0
160	130.0	127.0
200	131.1	127.0
250	130.5	126.5
315	130.0	126.0
400	130.0	125.0
500	129.8	123.5
630	128.3	122.0
800	126.9	119.5
1000	123.9	116.5
1250	122.0	114.0
1600	120.4	112.5
2000	120.9	114.0
2500	117.9	111.5
3150	117.2	110.0
4000	115.5	109.0
5000	114.5	108.5
6300	113.7	108.0
8000	113.9	109.5
10000	114.8	110.5
OASPL	140.5	136.6

3.2.7 Transportability

SRDX3.2.7-1
The sensor suite and the support equipment that is to be transported with the sensor suite shall be designed for ground and air transportation in accordance with best commercial or military practices**.**

3.2.8 Flexibility and Expansion

3.2.8.1 Operational Computer Resource Reserves

SRDX3.2.8.1-1
Addition and modification of computer resources in sensors of later flights shall be accommodated by the sensor designs.

3.2.8.1.1 Computer Resource Reserves for Operational Space Elements

For the purposes of this specification, the data processing subsystems of the operational sensor suite are defined to comprise all computer hardware and software.

SRDX3.2.8.1.1-1
The data processing subsystems of the sensor suite shall have 100 percent growth margin while meeting the original functional and performance computational requirements, including timing. This requirement allows the growth margin to be used if the government adds additional requirements.

3.2.8.1.1.1 Data Processing Processor Reserves

SRDX3.2.8.1.1.1-1
Within the processing environment of the data processing subsystems of the space elements, each processor shall have an instruction execution rate sufficient to process a workload that is 100 percent greater than the worst case processor utilization workload that could load that processor.

3.2.8.1.1.2 Data Processing Primary Memory Reserves

SRDX3.2.8.1.1.2-1
Within the environment of the data processing subsystems of the space elements, the primary memory for each processor shall have 100 percent greater memory capacity than the worst case memory size requirement for that primary memory component, if operating under a non-virtual operating system.

SRDX3.2.8.1.1.2-2
Within the environment of the data processing subsystems of the space elements, the primary memory for each processor shall have, or be capable of having, memory added (through modification, addition, or replacement) to attain, a 200 percent greater memory capacity than the worst case memory size requirement for that primary memory component.

3.2.8.1.1.3 Data Processing Peripheral Data Storage (Secondary Memory) Reserves

SRDX3.2.8.1.1.3-1
Within the environment of the data processing subsystems of the space elements, each peripheral data storage (secondary memory) component shall have 100 percent greater storage capacity than the worst case storage requirement for that peripheral data storage component.

SRDX3.2.8.1.1.3-2
Within the environment of the data processing subsystems of the space elements, each peripheral data storage (secondary memory) component shall have, or be capable of having, storage added (through modification, addition, or replacement) to attain, a 200 percent greater storage capacity than the worst case storage requirement for that peripheral data storage component.

3.2.8.1.1.4 Data Processing Data Transmission Media

SRDX3.2.8.1.1.4-1
Within the environment of the data processing subsystems of the space elements, each data transmission medium (e.g., local or global bus or channel) shall have sufficient capacity to support data throughput that is 50 percent greater than the worst case data throughput that could load that data transmission medium.

SRDX3.2.8.1.1.4-2
Within the environment of the data processing subsystems of the space elements, each data transmission medium (e.g., local or global bus or channel) shall have, or be capable of being augmented (through modification, addition, or replacement) to have, sufficient capacity to support data throughput that is 200 percent greater than the worst case data throughput that could load that data transmission medium.

3.2.8.1.1.5 Data Processing Software/Firmware

SRDX3.2.8.1.1.5-1
Any hardware augmentations necessary to meet the expansion requirements shall, where practical, be designed so that the software and firmware in the data processing subsystems of the space elements are upward compatible with the implementation of those augmentations.

3.3 DESIGN AND CONSTRUCTION

3.3.1 Materials

MIL-STD-1522A should be used as a guide for design and test of all pressurized systems.

SRDX3.3.1-1
Unless otherwise specified, the parts, materials, and processes shall be selected and controlled in accordance with contractor documented procedures to satisfy the specified requirements (reference MIL-STD-1543B).

3.3.1.1 Toxic Products and Formulations

SRDX3.3.1.1-1
The use of combustible materials or materials that can generate toxic outgassing or toxic products of combustion shall be compliant with applicable federal, state, and local laws and regulations.

3.3.1.2 Parts Selection

Care should be exercised in the selection of materials and processes for the sensor to avoid stress corrosion cracking in highly stressed parts and to preclude failures induced by hydrogen embrittlement.
Parts, materials, and processes should be selected to ensure that any damage or deterioration from storage or the space environment or the outgassing effects in the space environment would not reduce the performance of the sensor beyond the specified limits.

SRDX3.3.1.2-1
Parts for space usage shall be chosen to meet the reliability and operational service life requirements. (Use MIL-STD-1547B and the Preferred Parts List PPL-21, Goddard Space Flight Center, as guides.)

SRDX3.3.1.2-2
Parts shall be selected in accordance with the contractor’s Parts Management Plan.

SRDX3.3.1.2-3
The contractor shall be able to demonstrate via design and test or analysis that all parts meet the reliability and operational service life requirements.

3.3.1.3 Material Selection

SRDX3.3.1.3-1
Materials for the space equipment shall be selected for low outgassing using NASA SP-R-0 022A (NASA JSC) as a guide and resistance to the effects of incident radiation. All support facilities, including test facilities and launch base facilities, should comply with the grounding requirements of MIL-STD-1542B and NOAA S24.809.

SRDX3.3.1.3-2
Materials shall be selected that have demonstrated their suitability for the intended application.

SRDX3.3.1.3-3
Materials shall be corrosion resistant or be suitably treated to resist corrosion when subjected to the specified environments.

SRDX3.3.1.3-4
Where practicable, fungus inert materials shall be used.

SRDX3.3.1.3-5
A-basis material allowables shall be used for design. An A-basis allowable is defined as a value where 99 percent of a population of values is expected to equal or exceed the allowable, with a confidence of 95 percent.

SRDX3.3.1.3-6
Class I Ozone Depleting Substances (ODS) shall not be used in the design, test, manufacture, integration and assembly, handling, transportation, operations, maintenance, or disposal of the sensor.

SRDX3.3.1.3-7
Use of Class II ODS and Emergency Planning and Community Right to Know Act (EPCRA) Section 313 chemicals shall be identified and either eliminated or minimized, justified, and controlled.

SRDX3.3.1.3-8
A Hazardous Materials Management Program shall be developed in accordance with NAS 411.

3.3.2 Electromagnetic Radiation

3.3.2.1 Electromagnetic Interference (EMI) Filtering of Spacecraft Power

SRDX3.3.2.1-1
The sensor shall have EMI input filters installed on the sensor side of the power interface. This does not apply to the survival heater circuits which are controlled on the spacecraft side of the interface.

SRDX3.3.2.1-2
The filters shall provide both common-mode and differential-mode filtering capable of meeting EMC requirements in accordance with MIL-STD-1541A.

SRDX3.3.2.1-3
The filters shall be designed to withstand and suppress electrical transients.

3.3.2.2 Electromagnetic Compatibility

3.3.2.2.1 General

There are five macro-level interfaces to consider for EMC:

1) Interface between sensors and spacecraft bus
2) Interface between spacecraft and external environment
3) Interface between spacecraft and launch vehicle

4) Interface between spacecraft and ground support equipment
5) Interface between spacecraft bus/sensors and test equipment

There are four EMC interfaces:

1) Conducted Emissions/Susceptibility
2) Radiated Emissions/Susceptibility
3) Grounding
4) Wiring

3.3.2.2.2 Baseline Requirements

3.3.2.2.2.1 Sensor Electromagnetic Compatibility

SRDX3.3.2.2.2.1-1
The Electromagnetic Compatibility (EMC) requirements shall be in accordance with MIL-STD-461D and MIL-STD-1541A.

SRDX3.3.2.2.2.1-2
The sensor shall not impact the search and rescue mission during any mode of operation.

SRDX3.3.2.2.2.1-3
The spacecraft bus, sensors, ground support equipment, and test equipment shall be operated without performance degradation with each other, and the external environment.

3.3.2.2.2.2 Interface Margins

SRDX3.3.2.2.2.2-1
Each interface margin shall be the larger of the following:

1) At least 12 dB.
2) At least large enough to cover manufacturing variations from spacecraft to spacecraft and end-of-life variations.

SRDX3.3.2.2.2.2-2
Electro-explosive devices circuits shall have at least a 20 dB margin.

3.3.2.2.3 External Environment

SRDX3.3.2.2.3-1
The system shall operate without performance degradation in the following external environment.

Frequency	V/m
10 k-100M	*TBD*
100 M - 1 G	*TBD*
1 - 10 G	*TBD*
10 G - 40 G	*TBD*

SRDX3.3.2.2.3-2
The intended receivers shall operate without performance degradation for the external environment outside their pass band

SRDX3.3.2.2.3-3
The intended receivers shall survive and automatically recover for the external environment inside their pass band.

3.3.2.2.2.3 Spacecraft Charging from All Sources

SRDX3.3.2.2.2.3-1
The sensor shall operate without performance degradation due to surface charging, bulk charging, and deep charging in accordance with MIL-STD-1541A except paragraph 6.5.2.4.1.

3.3.2.3.3 Wiring

SRDX3.3.2.3.3-1
Power cables, supply and return wires shall be twisted to reduce electromagnetic contribution.

SRDX3.3.2.3.3-2
The power wiring shall be shield twisted pairs with EMI backshells.

SRDX3.3.2.3.3-3
The shield shall be terminated on the backshell.

SRDX3.3.2.3.3-4
Each power wire shall have a dedicated return.

3.3.2.3.4 Conducted and Radiated Interface Requirements

SRDX3.3.2.3.4-1
The interfaces shall meet the requirements (including CE101, CE102, CE106, CS101, CS103, CS104, CS105, CS114, CS116, RE101, RE102, RS101, and RS103) of MIL-STD-461D as tailored by MIL-STD-1541A as tailored within. CS114 and CS116 only apply to power cables. CS103, CS104, CS105, and CE106 apply only to subsystems with transmit/receive antennas. The upper frequency range of RE102 and RS103 shall be extended to envelope all sensor, transmitter, and receiver frequencies.

3.3.2.3.4.1 Radiated Emission RE101

SRDX3.3.2.3.4.1-1
The requirements shall be tailored by the magnetometer requirements *(TBD).*

3.3.2.3.4.2 Radiated Emissions RE102

SRDX3.3.2.3.4.2-1
The requirement shall be less than 100 dBμV/m except as tailored for the search and rescue receiver, the UHF receiver, the Satellite Ground Link System (SGLS) receiver, sensor receivers, and launch vehicle receivers *(TBD).*

3.3.2.3.4.3 Radiated Susceptibility RS101

SRDX3.3.2.3.4.3-1
The requirements shall be tailored by the magnetometer requirements *(TBD).*

3.3.2.3.4.4 Radiated Susceptibility RS103

SRDX3.3.2.3.4.4.-1
The requirements shall be tailored by the external RF environment and the UHF transmitter, the SGLS transmitter, and the launch vehicle transmitter *(TBD).*

3.3.3 Nameplates and Product Marking (See 5.2)

3.3.4 Workmanship

SRDX3.3.4-1
Critical steps of fabrication which are item-peculiar shall be detailed in drawing notes and figures which include appropriate workmanship criteria.

SRDX3.3.4-2
Workmanship relating to all other aspects of fabrication shall be in accordance with the Quality Control Plan approved for each manufacturing facility.

3.3.5 Interchangeability

SRDX3.3.5-1
All sensor subsystems shall be configured for modular replacement of components to expedite maintenance and repair.

SRDX3.3.5-2
All components, assemblies, subassemblies, and modules that are identical with respect to fit, form, and function shall be interchangeable.

SRDX3.3.5-3
Parts that are not functionally, electrically and dimensionally interchangeable shall have different part numbers.

3.3.6 Safety Requirements

SRDX3.3.6-1
Hazards to personnel, hardware, or the environment shall be identified, controlled, or eliminated during design, test, manufacture, integration and assembly, handling, transportation, and operations of the sensor.

SRDX3.3.6-2
Design and operational safety requirements shall be developed and implemented to eliminate or control personnel, hardware, or environmental hazards.

SRDX3.3.6-3
Sensor suites developed for this program shall comply in accordance with EWR 127-1 in the areas of design safety, flight termination, launch integration, and ground operations.

SRDX3.3.6-4
Software controlling hazardous systems or operations (e.g., propulsion systems, electro-explosive devices, electromechanical release devices, etc.) shall be assessed for hazard severity and probability in accordance with AFM 91-201 and using MIL-STD-882C as a guide.

SRDX3.3.6-5
A sensor safety program shall be established and maintained using MIL-STD-822C as a guide.

3.3.6.1 Design Safety Criteria

SRDX3.3.6.1-1
Interfaces shall be designed in accordance with the safety requirements in EWR 127-1.

SRDX3.3.6.1-2
The use of electro-explosive devices (EEDs) shall be avoided. EEDs may be used where the use of such devices can be shown to reduce risk.

SRDX3.3.6.1-3
Paraffin and other non-explosive actuators (NEA) shall be activated through the standard command and data interface, and within the sensor envelope.

SRDX3.3.6.1-4
Dedicated EED circuits shall not be included in the baseline standard interface.

SRDX3.3.6.1-5
Space debris shall not be generated.

SRDX3.3.6.1-6
Actuating circuitry shall be two-fault tolerant to unanticipated deployment or release.

SRDX3.3.6.1-7
All applicable safety-related explosive ordnance design requirements shall be met.

SRDX3.3.6.1-8
Explosive ordnance to be installed on a sensor shall be in accordance with DOD-E-83578A.

3.3.7 Human Engineering

SRDX3.3.7-1
The operator-hardware and operator-software interfaces shall be designed to maximize safety, efficiency, and usability, and minimize number of personnel, resources, skills, and training.

SRDX3.3.7-2
The operator-software interface shall be developed using open systems technology.

SRDX3.3.7-3
The operator-software interface shall be designed using an iterative design methodology consisting of rapid prototyping, usability evaluation, and feedback to design.

3.3.8 Nuclear Control

SRDX3.3.8-1
Provisions shall be made for the control of all nuclear materials, such as radioactive sources, if used in manufacturing, calibration, and checkout of certain mission sensors.

3.3.9 Security

3.3.9.1 Communications Security (COMSEC)

Communications security (COMSEC) measures provide protection for the transmission of sensitive information.

SRDX3.3.9.1-1
The probability that the sensor will accept the following as a valid command shall be no more than once over the life of each sensor :

a. An invalid command
b. Noise

SRDX3.3.9.1-2
The sensor shall check for invalid commands and execute only valid commands.

SRDX3.3.9.1-3
Invalid commands shall be reported in telemetry.

3.3.9.2 Computer Security (COMPUSEC)

Any sensor element that processes multiple security levels of data should comply with DOD 5200.28-STD, paragraph 3.1.1.3.

3.3.10 Government Furnished Property Usage

The government will provide standard scenes for sensor/EDR evaluations, where applicable.

3.3.11 Computer Resources

Computer resources include all computer software and the associated computational equipment included within the sensor.

3.3.11.1 Operational Computer Resources

3.3.11.1.1 Operational Computational Equipment

The computational equipment includes processing units; special-purpose computational devices; main storage; peripheral data storage; input and output units.

3.3.11.1.2 Operational Application Software (TBD)

3.3.11.1.3 Operating Systems Used in Operational Computers

3.3.11.1.3.1 Sensors Flight Software Requirements

3.3.11.1.3.1.1 Sensor Flight Software Version Control

SRDX3.3.11.1.3.1.1-1
All software and firmware shall be implemented with an internal identifier (embedded in the executable program) that can be included in the sensor engineering data.

SRDX3.3.11.1.3.1.1-2
This identifier shall be keyed to the configuration management process so that the exact version of software and firmware residing in the sensor can be determined at any time.

3.3.11.1.3.1.2 Sensor Flight Software Load

SRDX3.3.11.1.3.1.2-1
Loading of the sensor microprocessor via hardline shall take no longer than 10 minutes following a reset or power-up.

3.3.11.1.3.1.3 Sensor Flight Software On-Orbit Installation and Verification

SRDX3.3.11.1.3.1.3-1
Flight software shall be designed so that complete or partial revisions can be installed and verified on-orbit.

3.3.11.1.3.2 Programming Language

The government intends to determine the standard software language for operational application software after preliminary designs are complete. The government intends to do the same for flight software.

SRDX3.3.11.1.3.2-1
Sensor software shall be written in a higher order language except where assembly language is necessary for the satisfaction of sensor performance requirements or where its use is cost effective over the life of the sensor. (TBR)

3.3.11.1.4 Software Coding Conventions

SRDX3.3.11.1.4-1
Code shall be written such that no code is modified during execution.

3.3.11.1.5 Year 2000 Software Requirements

SRDX3.3.11.1.5-1
All information technology items shall be Year 2000 compliant, or non-compliant items shall be upgraded at no additional cost to be Year 2000 compliant by (TBS, but NLT December 31, 1999). Year 2000 compliant means information technology that accurately processes date/time data (including but not limited to, calculating, comparing and sequencing) from, into and between the twentieth and twenty-first centuries, and the years 1999 and 2000 and leap year calculations.

SRDX3.3.11.5.1-2
Year 2000 compliant information technology, when used in combination with other information technology shall accurately process date/time data if the other information technology properly exchanges date/time data with it.

3.3.12 Sensor Design Requirements

3.3.12.1 General Structural Design

SRDX3.3.12.1-1
The primary support structure for the sensor equipment shall possess sufficient strength, rigidity, and other characteristics required to survive the critical loading conditions that exist within the envelope of handling and mission requirements.

3.3.12.2 Strength Requirements

3.3.12.2.1 Yield Load

SRDX3.3.12.2.1-1
The structure shall be designed to have sufficient strength to withstand simultaneously the yield loads, applied temperature, and other accompanying environmental phenomena for each design condition without experiencing yielding or detrimental deformation.

3.3.12.2.2 Ultimate Load

SRDX3.3.12.2.2-1
The structure shall be designed to withstand simultaneously the ultimate loads, applied temperature, and other accompanying environmental phenomena without failure.

3.3.12.3 Stiffness Requirements

3.3.12.3.1 Dynamic Properties

SRDX3.3.12.3.1-1
The structural dynamic properties of the equipment shall be such that its interaction with the sensor control subsystem does not result in unacceptable degradation of performance.

3.3.12.3.2 Structural Stiffness

SRDX3.3.12.3.2-1
Stiffness of the structure and its attachments shall be controlled by the equipment performance requirements and by consideration of the handling and launch environments.

SRDX3.3.12.3.2-2
Special stowage provisions shall be used, if required, to prevent excessive dynamic amplification during transient flight events.

3.3.12.3.3 Component Stiffness

SRDX3.3.12.3.3-1
The fundamental resonant frequency of a component weighing 23 kilograms or less shall be 50 Hertz or greater when mounted on its immediate support structure.

SRDX3.3.12.3.3-2
Detailed analyses of the potential responses of the component to inputs from the adjoining structure(s) shall be required for components weighing 23 kilograms or less and having fundamental resonant frequencies of less than 50 Hertz (TBR).

SRDX3.3.12.3.3-3
A test-verified model is preferred when available, and shall be used if the sensor lowest frequency is less than 50 Hz as shown by analysis.

3.3.12.4 Structural Factors of Safety

The factor of safety of the structure is the ratio of the limit load to the allowable load.

3.3.12.4.1 Flight Limit Loads

SRDX3.3.12.4.1-1
The design factors of Table 3.3.12.4.1 below shall be applied to all loading conditions.

Table 3.3.12.4.1 Structural Design Factors of Safety

Design and Test Options	Design Factor of Safety of Limit Loads	
	Yield (FSy)	Ultimate (FSu) Unmanned Events
1. Dedicated Test Article	1.10	1.25
2. Test One Flight Article	1.25	1.40
3. Proof Test Each	1.10	1.25

Flight Article 4. No Static Test	1.60	2.00

SRDX3.3.12.4.1-2
The level of required analysis increases significantly with increased option number. For the no-static-test option, a detailed and comprehensive structural analysis shall be conducted. (TBR)

SRDX3.3.12.4.1-3
The structural analysis documentation shall be available for review by the spacecraft contractor. (TBR)

SRDX3.3.12.4.1-4
The flight hardware shall be capable of withstanding all worst-case load conditions to which it may be exposed during ground (handling and transportation), test, pre-launch, launch, and on-orbit operations.

SRDX3.3.12.4.1-5
Positive structural margins of safety shall be maintained so that the sensor can meet all design requirements after being subjected to the worst case load combinations.

SRDX3.3.12.4.1-6
In those cases involving maintenance of sensor critical components for on-orbit operations, the precision elastic limits shall be used for structural materials.

SRDX3.3.12.4.1-7
All composite structures and structural bonded joints shall be proof tested, regardless of safety factor, however, a metallic structure is usually qualified such that each unit will not have to be tested, or it is protoqualed. The no-static-test option allows the capability of the structure to be determined via purely analytical methods. The analytical models are not being verified by test, but verified by the integrator/government for accuracy.

3.3.12.4.2 Pressure Loads (TBR)

SRDX3.3.12.4.2-1
Sensors with pressurized systems shall follow the requirements in accordance with EWR 127-1 for the design of pressurized systems and using MIL-STD-1522A for guidance.

SRDX3.3.12.4.2-2
Factors of safety for pressure loads shall be determined individually for each pressure vessel, based on tests to establish material characteristics and an analysis of life requirements and other environmental exposure.

SRDX3.3.12.4.2-3
Proof and burst pressure factors shall be established at levels that ensure structural integrity, structural life, and safety throughout all phases. The values listed in Table 3.3.12.4.2 below are to be considered as limiting lower bounds.

Table 3.3.12.4.2 Factors of Safety for Pressurized Components

Component	Design Ultimate	Acceptance (Proof)	Qualification (Burst)
Pneumatic Vessels (SVE)[a]	2.00	1.50[b]	2.00[b]
Pneumatic Vessels (GSE)[a]	4.00	2.00[b]	4.00
Lines, Fittings, and Hoses			
Less than 3.81 cm diameter	4.00	2.00[b]	4.00[b]
3.81 cm diameter and larger	1.50	1.10[b]	1.50[b]

Other Pressurized Components		2.50	2.00[b]	2.50[b]
Notes:				
a.	Factors of safety shown are minimum values applicable to metallic pressure vessels for which ductile fracture mode is predicted via a combination of stress and fracture mechanics analyses. Design of metallic pressure vessels for which brittle fracture mode is predicted by these analyses should be in accordance with fracture mechanics methodology wherein the proof factor as well as the design ultimate factor of safety shall be established to provide a minimum of four times the specified service life against mission requirements. In addition, a fracture control program should be established to prevent structural failure due to the initiation or propagation of flaws or crack-like defects during fabrication, testing, and service life.			
b.	No measurable (TBR) yielding is permitted at acceptance (proof) test pressure and no rupture at qualification pressure.			

3.3.12.5 Design Load Conditions

SRDX3.3.12.5-1
The sensor equipment shall be capable of withstanding all design load conditions to which it is exposed in all mission phases, as applicable: ground, prelaunch, erection, post-launch, boost and orbit.

SRDX3.3.12.5-2
During the orbit phase, all of the following shall be considered: maneuvering loads, vehicle spin, meteoroid environment, radiation environment, and other environmental factors, such as thermal effects due to internal heating, solar heating, eclipses, and extreme cold due to ambient space environment.

3.3.12.6 Sensor Fluid Subsystems

3.3.12.6.1 Tubing

SRDX3.3.12.6.1-1
Tubing design shall incorporate provisions for cleaning and to allow proof testing.

3.3.12.6.2 Separable Fittings

SRDX3.3.12.6.2-1
Separable fittings shall have redundant sealing surfaces, such as double "O" rings, and be of the "parallel loaded" type. "Parallel loaded" means that the fitting contains a compressed element which exerts outward pressure on the other elements of the fitting such that both seals are maintained even if relaxation occurs.

SRDX3.3.12.6.2-2
Separable fittings shall have provisions for locking.

SRDX3.3.12.6.2-3
Separable fittings shall be accessible for leak tests and for torque checks.

SRDX3.3.12.6.2-4
Separable fittings shall not be designed or assembled with lubricants or fluids that could cause contamination or could mask leakage of a poor assembly.

SRDX3.3.12.6.2-5
Separable fluid fittings shall not use "B" nuts.
The only fitting assemblies permitted shall meet all of the following constraints:

SRDX3.3.12.6.2-6
(1) The fittings shall be comprised of one or more compressed or internally pressure-energized members which maintain a seal even if stress relaxation occurs in any of the other components.

SRDX3.3.12.6.2-7
(2) The fittings shall have redundant seals in series.

SRDX3.3.12.6.2-8
(3) The fittings shall be lockwired to prevent any rotation between the fitting and the nut.

3.3.12.7 Moving Mechanical Assemblies

SRDX3.3.12.7-1
Deployment mechanisms, sensor mechanisms, pointing mechanisms, drive mechanisms, de-spin mechanisms, separation mechanisms, and other moving mechanical assemblies on sensors shall be in accordance with MIL-A-83577B in order to increase reliability of Moving Mechanical Assembly (MMA's) and facilitate integration and test activities.

SRDX3.3.12.7-2
System level test impacts shall be considered in the sensor design; for example, gimballing in a 1 'g' environment, momentum compensation, and the use of GSE.

3.3.12.7.1 Actuating Devices (See 3.3.6.1)

3.3.12.7.2 Sensor Disturbance Allocation

The spacecraft contractor is to provide estimates of allowable disturbance torque, vibration, and end-of-travel or latch-up loads to the sensor contractor. The design will be an iterative process to accommodate the requirements of both the spacecraft contractor and sensor contractor.

SRDX3.3.12.7.2-1
The sensor contractor shall provide data that will allow the spacecraft contractor to ensure that the "swept" or deployed volume is verified to ease integration and operation, accounting for all distortions and misalignments.

SRDX3.3.12.7.2-2
Early estimate of gimbaled masses, inertia's and cg's shall be provided to size the control components to meet pointing and stability requirements.

3.3.12.7.3 Sensor Mechanisms

SRDX3.3.12.7.3-1
All sensor mechanisms which require restraint during launch shall be caged during launch without requiring power to maintain the caged condition.

3.3.12.7.4 Uncompensated Momentum

SRDX3.3.12.7.4-1
Each sensor having movable components shall not exceed an uncompensated momentum contribution to be defined and agreed to in an ICD between the sensor contractor and the spacecraft contractor.

3.3.12.7.5 Sensor Disturbance Allocations

3.3.12.7.5.1 Constant and Periodic Disturbance Torque Limits

SRDX3.3.12.7.5.1-1
The magnitude of the disturbance torque that the sensor imparts to the spacecraft shall be in the acceptable region of Figure 3.3.12.7.5.1.

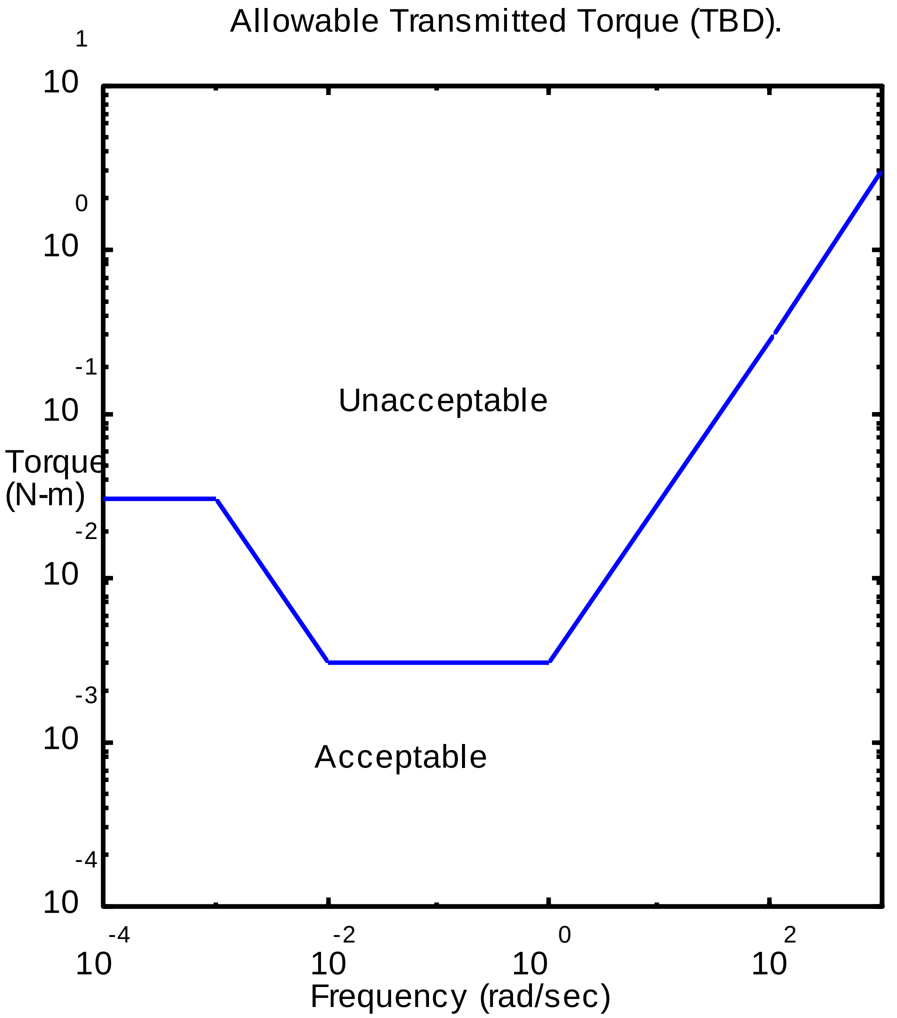


Figure 3.3.12.7.5.1 Allowable Transmitted Torque

3.3.12.7.5.2 Torque Profile Documentation

SRDX3.3.12.7.5.2-1
The sensor contractor shall provide the actual sensor torque versus time profile to the spacecraft contractor for documentation in the ICD.

3.3.12.7.5.3 Thrust Direction Definition

SRDX3.3.12.7.5.3-1
The sensor contractor shall provide to the spacecraft contractor the magnitude and direction of net thrust resulting from the expulsion of expendables by the sensor for documentation in the ICD. (TBR)

3.3.12.8 Magnetics

The use of large quantities of magnetic materials should be avoided where possible.

SRDX3.3.12.8-1
If magnets are inherent to the sensor design, early estimates of magnetic fields and residual magnetic dipole moments shall be provided to the spacecraft contractor.

SRDX3.3.12.8-2
A full magnetic survey shall be conducted by the sensor contractor if the sensor has a total residual uncompensated magnetic moment greater than (TBD) ampere-turn-meter-square.

3.3.12.9 Access

3.3.12.9.1 Access Identification

SRDX3.3.12.9.1-1
The sensor contractor shall provide to the spacecraft contractor access requirements for documentation in the ICD.

3.3.12.9.2 General Access

SRDX3.3.12.9.2-1
All items to be installed, removed, or replaced at the spacecraft level shall be accessible without disassembly of the unit.

3.3.12.10 Mounting/Handling

3.3.12.10.1 Handling Fixtures

SRDX3.3.12.10.1-1
The sensor contractor shall provide proof tested handling fixtures for each subsystem.

SRDX3.3.12.10.1-2
Handling fixtures shall be designed to 5 times limit load for ultimate and 3 times limit load for yield.

SRDX3.3.12.10.1-3
Handling fixtures shall be tested to 2 times working load.

3.3.12.10.2 Mounting Orientation

SRDX3.3.12.10.2-1
Sensors shall be capable of being mounted to the spacecraft with the spacecraft in the horizontal or vertical position.

3.3.12.10.3 Sensor to Spacecraft Integration and Test Mounting

SRDX3.3.12.10.3-1
Sensors shall be capable of being mounted or removed without removal of other sensors or subsystem.

3.3.12.10.4 Non-Flight Equipment

SRDX3.3.12.10.4-1
The sensor contractor shall provide to the spacecraft contractor information on all items to be installed or removed prior to flight, for identification in the ICD.

3.3.12.11 Venting

SRDX3.3.12.11-1
Sensor contractors shall provide to the spacecraft contractor the location, size, path and operation time of vents in the sensors for inclusion in the ICD.

SRDX3.3.12.11-2
Sensor purge requirements, including type of purge gas, flow rate, gas purity specifications, filtration and desiccant requirements, and the limit for purge interruption, shall be provided to the spacecraft contractor for documentation in the ICD.

3.3.13 Operational Ground Equipment: General Design Requirements (TBD)

3.3.14 Non-operational Ground Equipment: (TBD)

3.3.15 General Construction Requirements

3.3.15.1 Processes and Controls for Space Equipment

Acceptance and flight certification of sensor equipment is based primarily on an evaluation of data from the manufacturing process**.**

SRDX3.3.15.1-1
The manufacturing process for sensor equipment shall be accomplished in accordance with documented procedures and process controls which assure the reliability and quality required for the mission.

SRDX3.3.15.1-2
These manufacturing procedures and process controls shall be documented to give visibility to the procedures and specifications by which all processes, operations, inspections, and tests are to be accomplished by the contractor.

SRDX3.3.15.1-3
Each lot shall be manufactured, tested and stored with sequential lot numbers that indicate the date of manufacture assigned to each lot. (Typically, use three digits for the day of the year and two digits for the year.

SRDX3.3.15.1-4
Contractor documentation shall include each material required.

SRDX3.3.15.1-5
Contractor documentation shall include the point it enters the manufacturing flow.

SRDX3.3.15.1-6
Contractor documentation shall include the controlling specification or drawing.

SRDX3.3.15.1-7
The documentation shall indicate required tooling corresponding to each applicable process or material listed.

SRDX3.3.15.1-8
The documentation shall indicate facilities and test equipment corresponding to each applicable process or material listed.

SRDX3.3.15.1-9
The documentation shall indicate the manufacturing check points corresponding to each applicable process or material listed.

SRDX3.3.15.1-10
The documentation shall indicate the quality assurance verification points corresponding to each applicable process or material listed.

SRDX3.3.15.1-11
The documentation shall indicate the verification procedures corresponding to each applicable process or material listed.

SRDX3.3.15.1-12
The specifications, procedures, drawings, and supporting documentation shall reflect the specific revisions in effect at the time the items were produced.

SRDX3.3.15.1-13
Flow charts and the referenced specifications, procedures, drawings, and supporting documentation become the manufacturing process control baseline and shall be retained by the contractor for reference.

SRDX3.3.15.1-14
All changes to the baseline processes used, or the baseline documents used shall be recorded by the contractor following the establishment of the manufacturing baseline. It is recognized that many factors may warrant making changes to this documented baseline; however, these changes provide the basis for flight accreditation of manufactured or of subsequent flight items.

SRDX3.3.15.1-15
The manufacturing process and control documents for sensor equipment shall provide a contractor-controlled baseline that assures that any subsequent failure or discrepancy analysis that may be required can identify the specific manufacturing materials and processes that were used for each item. In that way, changes can be incorporated to a known baseline to correct the problems.

3.3.15.1.1 Assembly Lots

SRDX3.3.15.1.1-1
To the extent practicable, parts for use in sensor equipment shall be grouped together in individual assembly lots during the various stages of their manufacture to assure that all devices assembled during the same time period use the same materials, tools, methods, and controls.

SRDX3.3.15.1.1-2
Parts and devices for sensor equipment that cannot be tested adequately after assembly without destruction of the item, such as explosive ordnance devices, some propulsion components, and complex electronics, shall have lot controls implemented during their manufacture to assure a uniform quality and reliability level of the entire lot.

3.3.15.1.2 Contamination (TBR)

A system level contamination plan is to be developed by the spacecraft contractor. Sensor and other sensor equipment and facility contamination and cleanliness requirements are to be considered along with the spacecraft requirements and the resulting contamination budget provided to each sensor contractor.

SRDX3.3.15.1.2-1
A contamination control program shall be developed and implemented.

SRDX3.3.15.1.2-2
The contamination requirements shall be provided to the spacecraft contractor for inclusion in the ICD.

3.3.15.1.2.1 Contamination Control Requirements

SRDX3.3.15.1.2.1-1
The sensor contractor shall perform independent contamination analyses to identify, locate and size components sensitive to contamination and assess, calculate or measure the maximum allowable particulate and molecular film (nonvolatile residue, or NVR) contamination consistent with top level mission performance and lifetime specifications.

SRDX3.3.15.1.2.1-2
The sensor contractor shall provide contamination limits to the spacecraft contractor for documentation in the ICD.

3.3.15.1.2.2 Facility Environmental Requirements

SRDX3.3.15.1.2.2-1
The sensor contractor shall describe the required integration and test environments in accordance with the definitions of FED-STD-209E.
The sensors is to be integrated with the spacecraft in a Class 10,000 (TBR) cleanroom environment and maintained in that environment as much as possible during the integration and test flow.

SRDX3.3.15.1.2.2-2
The facility requirements shall be documented and should include air cleanliness, air flow and recirculation rates, temperature and humidity, and tolerance for out-of-spec conditions (i.e. intermittent spikes) as a minimum.

SRDX3.3.15.1.2.2-3
Requirements shall include verification by standard testing methods to be performed at regular, specified intervals.
3.3.15.1.2.2.1 Ground Support Equipment (GSE) Cleanliness Requirements

SRDX3.3.15.1.2.2.1-1
The sensor contractor shall document the need for contamination control of all GSE entering cleanrooms.

SRDX3.3.15.1.2.2.1-2
All GSE used inside thermal/vacuum facilities shall be cleaned and vacuum compatible.

3.3.15.1.2.3 Sensor Inspection and Cleaning During I&T

SRDX3.3.15.1.2.3-1
Inspections and cleaning by the sensor contractor during Integration and Test (I&T) shall be coordinated and defined in the ICD. Sensor contractors should consider having defined “pass/fail” criteria consistent with top level mission performance and lifetime specifications and the derived contamination budget for that I&T milestone. Sensor contractors should pay particular attention to any I&T activity utilizing thermal/vacuum test facilities.

3.3.15.1.2.4 Sensor Purge Requirements

SRDX3.3.15.1.2.4-1
Sensor purge requirements, including type of purge gas, flow rate, gas purity specifications, filtration and desiccant requirements, and the tolerance for purge interruption, shall be provided to the spacecraft contractor for documentation in the ICD.

3.3.15.1.2.5 Fabrication and Handling

SRDX3.3.15.1.2.5-1
Fabrication and handling of sensor equipment shall be accomplished in a clean environment.

SRDX3.3.15.1.2.5-2
Attention shall be given to avoiding non-particulate (chemical) as well as particulate air contamination.

SRDX3.3.15.1.2.5-3
To avoid safety and contamination problems, the use of liquids shall be minimized in areas where initiators, explosive bolts, or any loaded explosive devices are exposed.

3.3.15.1.2.6 Device Cleanliness

The particulate cleanliness of internal moving subassemblies should be maintained to at least level 500 as defined in MIL-STD-1246C.

SRDX3.3.15.1.2.6-1
External surfaces shall be visibly clean.

3.3.15.1.2.7 Outgassing Sensor Sources of Contamination

The spacecraft contractor is to coordinate handling of the issue of material outgassing

SRDX3.3.15.1.2.7-1
Sensor contractors shall identify and characterize all sources of contamination that can be emitted from the sensor.

SRDX3.3.15.1.2.7-2
At a minimum, the characterization shall include the material name, the amount, the emission rate, and its location.

SRDX3.3.15.1.2.7-3
The extent to which outgassing products have access to exterior surfaces shall also be considered.

SRDX3.3.15.1.2.7-4
Data from the American Society for Testing and Materials (ASTM) E-595 test for percent total mass loss (%TML) and percent collected volatile condensable material (%CVCM) shall be used. Materials with the following properties are recommended: Total Mass Loss (TML) less than 1.0%; production of Collected Volatile Condensable Material (CVCM) less than 0.1% when tested under conditions of ASTM E595-93 or equivalent. Composite materials are an exception.

SRDX3.3.15.1.2.7-5
The outgassing chemical species and any tendency to photodeposit in an Ultraviolet (UV) or energetic particle radiation environment shall be identified and quantified.

SRDX3.3.15.12.7-6
The sensor contractors shall consider effects on materials due to the planned space environment, including radiation, vacuum, thermal cycles, and atomic oxygen.

SRDX3.3.15.1.2.7-7
If voltage over 60 V (TBR) are present, the design shall be protected (e.g., potting, pressure vessel) and tested for arcing.

SRDX3.3.15.1.2.7-8
Items that might otherwise produce deleterious outgassing while on orbit shall be baked for a sufficient time to drive out all but an acceptable level of outgassing products prior to installation in the experiment or sensor.

3.3.15.1.2.8 Atomic Oxygen Contamination

Sensor materials selection should minimize the generation of particulate and molecular film contamination via interaction with atomic oxygen (AO). Atomic oxygen fluence is shown in (TBS).

SRDX3.3.15.1.2.8-1
Sensor contractors shall consider the effects of atomic oxygen in the space environment.

SRDX3.3.15.1.2.8-2
The sensor shall meet performance requirements during exposure to atomic oxygen experienced during a 833 km polar orbit for seven years.

3.3.15.1.3 Electrostatic Discharge

SRDX3.3.15.1.3-1
Appropriate provisions shall be made to avoid and to protect against the effects of static electricity generation and discharge in areas containing electrostatic sensitive devices such as microcircuits, initiators, explosive bolts, or any loaded explosive device. DOD-HDBK-263 provides examples of appropriate provisions.

SRDX3.3.15.1.3-2
There shall be a capability to ground both equipment and personnel working on and around the sensor, subsystems, and components.

3.4 DOCUMENTATION

3.4.1 Specifications

The sensor contractor is responsible for documenting the functional and physical requirements for the sensors in a hierarchical set of specifications, comprising sensor, subsystem, and component levels. MIL-STD-961D, Notice 1 provides guidance on hierarchical specifications. Lower level specifications may be used to define requirements for software or individual units.

3.4.2 Interface Control Documents

The spacecraft contractor is responsible for developing the Sensor to Spacecraft ICD. The sensor contractor is responsible for providing interface design description data to the spacecraft contractor for inclusion in the Sensor/Spacecraft ICD.

3.4.3 Drawings and Associated List

SRDX3.4.3-1
Equipment designed for the sensor shall be documented in drawings and associated lists.

3.4.4 Software (Including Databases).

Sensor software and databases should be developed and managed in accordance with MIL-STD-498 and NOAA S24.806 software standards. MIL-STD-498 will take precedence.

3.4.5 Technical Manuals

Technical manuals should meet the requirements of NOAA Standards S24.801,S24.806, and S24.809 (TM 86-01).

3.5 LOGISTICS (TBD)

Integrated Logistics Support (ILS) will minimize the impact on NPOESS of the existing support infrastructure while ensuring the lowest NPOESS life cycle cost and while providing full and timely logistics response.

3.5.1 Maintenance Planning (TBD)

All maintenance procedures will be approved by the government.

3.5.1.1 Sensor Maintenance Concepts (TBD)

The ground support equipment should be addressed by the sensor contractor.

3.5.2 Support Equipment (TBD)

The need for unique support equipment should be minimized by the careful selection of Commercial-Off-The-Shelf (COTS) hardware and software.

3.5.3 Packaging, Handling, Storage, and Transportation (PHS&T) (TBD)

The contractor should provide a PHS&T plan which will cover all PHS&T issues for the sensor.

3.5.4 Facilities (TBR)

Existing government facilities may be available for operations, maintenance, or storage of sensors.

3.6 PERSONNEL AND TRAINING (TBD)

3.7 SENSOR SUITE COMPONENT CHARACTERISTICS (if required) (TBD)

4. QUALITY ASSURANCE AND TESTING PROVISIONS

4.1 QUALITY ASSURANCE

The high reliability required of the sensor suite is achieved by the designs, design margins, and by the manufacuring process controls imposed at each and every level of assembly. The design and design margins should ensure that the sensor suite is capable of performing its mission in the space environment. The manufacturing process controls are intended to ensure that a known quality product is manufactured to meet the design requirements and that any changes required can be made based on a known baseline. To ensure successful operation of the sensor suite, attention to every detail is required at every level of assembly throughout development, manufacture, qualification, and testing, starting with the parts, materials, and processes used.

SRDX4.1-1
The sensor suite contractor shall ensure that quality assurance requirements flow down to all subcontractors.

4.1.1 Special Tests and Examinations

4.1.1.1 Inspections and Tests of the Sensor

4.1.1.1.1 Sensor Parts, Materials, and Process Controls.

Parts, materials, and process controls are to be applied during production of all items to ensure that a reliable sensor is fabricated.

SRDX4.1.1.1.1-1
The tools, processes, parts and materials used in the fabrication of the sensor shall be controlled and inspected to ensure compliance with approved manufacturing processes and controls.

4.1.1.1.2 Sensor Records.

SRDX4.1.1.1.2-1
The contractor shall maintain records documenting the status of the sensor following assignment of serial numbers.

SRDX4.1.1.1.2-2
Each sensor item shall have inspection records and test records maintained by serial number to provide traceability from sensor usage to production lot data for the devices.

SRDX4.1.1.1.2-3
The contractor shall maintain complete records for the sensor items and have them available for review during the service life of the sensor.

SRDX4.1.1.1.2-4
The records shall indicate all relevant test data; all rework or modifications; and all installations and removals for whatever reason.

SRDX4.1.1.1.2-5
Ground test equipment items shall have inspection records and test records maintained by serial number for the service life of the item.

4.1.1.1.3 Sensor Manufacturing Screens

SRDX4.1.1.1.3-1
The contractor shall subject each level of assembly to in-process manufacturing and assembly screens to ensure compliance with the specified requirements to the extent practicable.

SRDX4.1.1.1.3-2
At each level of assembly, the contractor shall subject each completed unit to visual inspection to ensure that it is free of obvious defects and is meets specified physical limits.

4.1.1.1.4 Non-conforming Material

SRDX4.1.1.1.4-1
The contractor shall reject all material, components, or assemblies that do not meet the established tolerance limits set for the acceptance limits in the in-process screens. Any rejected material, component, or assembly may be reworked and re-screened in accordance with established procedures, if the rework is not so extensive as to jeopardize the lot identity of the material or assembled unit. If the reworked material or assembled unit subsequently passes the in-process screens, it can again be considered part of the lot.
Non-conforming material or assembled units that do not satisfy these rework criteria will be considered scrap.

SRDX4.1.1.1.4-2
Reassignment of assembled units to a different lot shall not be made.

4.1.1.1.5 Sensor Design Verification Tests

SRDX4.1.1.1.5-1
The contractor shall perform design verification testing to demonstrate that new or modified designs comply with the specified performance margins.

4.2 TESTING

4.2.1 Philosophy of Testing

NPOESS will employ the following test strategy: One flight unit will be subjected to protoqualification level testing, subsequent flight units will be acceptance level tested.

4.2.2 Location of Testing

Tests and evaluations of the sensor elements may be conducted at in-plant test facilities, which may include subcontractor's facilities and/or at a government-approved test facility. Tests of parts, materials, software units, ground equipment and computer software may also take place at in-plant test facilities, (including subcontractor's facilities or at a government-approved test bed).

4.2.3 Physical Models

4.2.3.1 Engineering Development Unit (EDU)

SRDX4.2.3-1
The EDU shall have the form, fit and function of the production unit.

SRDX4.2.3-2
A EDU , developed and fabricated by the sensor contractor, shall be provided for the sensor suite that will be integrated on the spacecraft.

SRDX4.2.3-3
The EDU shall accurately represent (within 0.1Kg) the mass and mass distribution of the actual flight sensor but not necessarily the correct moments of inertia.

4.2.3.2 Mass Model

The requirement for mass models will be determined prior to PDR. (TBR)

4.2.3.3 Spacecraft/Sensor Mechanical Interface Simulator (TBS)

4.2.3.4 Spacecraft/Sensor Electrical Interface Simulator (TBS)

4.2.4 Math Model Requirements

The interface requirements for the mathematical models are defined in this section.
Thermal and structural models are required for the spacecraft and each of the mission sensors to accurately define the thermal, structural and dynamic loads at each sensor/spacecraft interface.

4.2.4.1 Finite Element Model

These models are to be used to analyze the structural and dynamic characteristics of each sensor. The models will be used to determine the sensor structural adequacy to withstand transportation, launch and on-orbit loads. Also, they will be used to predict sensor structural resonant frequencies. The satellite/launch vehicle loads analysis will be used in the development and definition of the sensor/spacecraft interface loads.

SRDX4.2.4.1-1
A structural Finite Element Model using NASTRAN shall be provided for the sensor suite.

SRDX4.2.4.1-2
If the sensor has any structural frequencies less than 50 Hz, a test-verified sensor dynamic (modal) model shall be provided.

4.2.4.2 Thermal Math Model

Two mathematical models, provided by the sensor contractor, will be used in defining each sensor/spacecraft thermal interface. The sensor model will be integrated into a satellite model to define the satellite/launch vehicle interface. All models will use software and formats that are acceptable to the spacecraft contractor. All models shall be fully documented to permit ease of use by other contractors in the system.

SRDX4.2.4.2-1
The sensor contractor shall develop a sensor surface geometric model and a reduced node thermal math model.

SRDX4.2.4.2-2
The contractor shall provide adequate documentation for both models for easy incorporation in system-level models and analyses.

SRDX4.2.4.2-3
The contractor shall develop a geometric math model (GMM), including 50 external surfaces or less, in TRASYS or compatible format.

SRDX4.2.4.2-4
The contractor shall develop a thermal math model (TMM) of 50 nodes or less in a SINDA compatible format to correlate pretest temperature predictions with the test data from the thermal balance test.

SRDX4.2.4.2-5
The TMM shall represent all external surfaces.

SRDX4.2.4.2-6
The thermal models shall include an adequate level of detail to predict, under worst case hot and cold conditions, all critical temperatures, including those that drive operational and survival temperature limits and heater power. Worst case conditions include variations in season, orbit selection, orbital time, and environmental flux parameters (seasonal and spatial) and a rational combination of the effects of design tolerances, fabrication uncertainties, material differences, and degradation due to aging. See Table 3.2.4.7.3.2 for cold and hot worst case environmental parameters.

SRDX4.2.4.2-7
Models shall use conservative values for conduction, absorption, emission, and MLI effective emittance, and consider contact resistance.

SRDX4.2.4.2-8
A thermal math model shall be used to correlate pretest temperature predictions with the test data from the thermal balance test. As a goal, correlation of test results to the thermal model predictions should be within $\pm$ 3°C.

SRDX4.2.4.2-9
The sensor contractor shall document the nodal description and results of the detailed thermal analysis.

4.2.5 Structural Analyses

The spacecraft contractor is to provide mission-specific information for maximum equivalent loads to the sensor contractor for his static loads analyses.

SRDX4.2.5-1
A structural analysis using maximum equivalent loads shall be conducted on the sensor suite.

SRDX4.2.5-2
Those sensors with modes under 50 Hz shall have a full modal survey test completed in a base fixed configuration to obtain all mode shapes and frequencies to correlate the dynamics model.

SRDX4.2.5-3
Modal surveys shall be conducted in accordance with MIL-STD-1540C (TBR).

SRDX4.2.5-4
A static loads test shall be conducted in accordance with MIL-STD-1540C (TBR), on the first production sensor if the loads predicted by the model exceed the maximum equivalent flight values.

SRDX4.2.5-5
The sensor contractor shall coordinate on the spacecraft contractor’s analyses. The two parties should reach an agreement about assumptions and model development either by test or by close coordination between the two structural analysis groups.

4.2.6 Developmental Testing

SRDX4.2.6-1
Developmental testing shall be conducted in accordance with MIL-STD-1540C (TBR).

4.2.7 Acceptance and Protoqualification Testing

A comprehensive sensor test program, conducted in conjunction with the spacecraft test program, will demonstrate that the sensor can meet its performance requirements and will ensure that all interface requirements are satisfied. These interface requirements will include interface structural and thermal loads, electrical power, electrical signals and other interface performance characteristics for ground handling, launch, deployment (where applicable), and on-orbit operations as well as for worst case systems tests conducted after delivery to the spacecraft contractor. ALL of the tests will be conducted by the sensor contractor before delivery of the instruments to the spacecraft contractor. Additional tests will be conducted at the satellite level after integration of the sensor onto the spacecraft. The types of testing to be performed by the spacecraft contractor include:

- Thermal vacuum and Thermal cycling
- EMI/EMC characterization to understand and measure radiative and conductive emissions and susceptibility
- Static and Dynamic structural testing (including pressure vessel and ordnance testing)
- Electrical and Mechanical functional testing to demonstrate performance
- Calibration: Radiometric and Geometric

SRDX4.2.7-1
Protoqualification level testing shall be required for one flight unit and its subsystems, with acceptance level testing for all remaining flight units and their subsystems.

SRDX4.2.7-2
All protoqualification and acceptance shall be done in accordance with MIL-STD-1540C (TBR) unless specified otherwise in this document

SRDX4.2.7-3
All protoqualification tests shall be conducted with hardware of the final design that has passed the in-process production screens.

SRDX4.2.7-4
The sensor contractor shall perform comprehensive radiometric/geometric calibration at multiple levels of assembly as approved by the government.

4.2.7.1 Random Vibration Testing

The random vibration test levels are dependent on the payload fairing internal acoustic environment and design of the spacecraft bus.

4.2.7.1.1 Acceptance Level Random Vibration Testing

The test levels found in Table 4.2.7.1.1 and Figure 4.2.7.1.1 are considered a conservative estimate of the random vibration environment on a representative spacecraft bus. The test levels shown in Table 4.2.7.1.1 are the minimum test levels recommended to detect workmanship defects.

SRDX4.2.7.1.1-1
The test duration shall be 1 minute per axes for acceptance level testing.

SRDX4.2.7.1.1-2
In no case shall the acceptance test levels for the sensor or its subsystems be less than those shown in Table 4.2.7.1.1.

Table 4.2.7.1.1 Random Vibration - Acceptance Test Levels

Frequency	Acceleration Spectral Density (G^2/Hz)

20	0.01
20 to 160	+3 dB/oct
160 to 250	0.08
250 to 2000	-3 dB/oct
2000	0.01
Overall	7.4 Grms

The plateau acceleration spectral density (ASD) level may be reduced for components between 25 kg and 200 kg according to the component weight (W) up to a maximum of 9 dB as follows:
dB reduction = 10 LOG(W/25)
$ASD_{(plateau)}$level = 0.08 x (25/W)
where W = component weight in kg

SRDX4.2.7.1.1-3
The sloped portions of the spectrum shall be maintained at ± 3 dB/oct. Therefore, the lower and upper break points, or frequencies at the ends of the plateau become:

F_L = 160 (25/W) F_L = frequency break point low end of plateau

F_H = 250 (W/25) F_H = frequency break point high end of plateau

SRDX4.2.7.1.1-4
The test spectrum shall not go below 0.01 G^2/Hz. For components whose weight is greater than 200 kg, the workmanship test spectrum is 0.01 G^2/Hz from 20 to 2000 Hz with an overall level of 4.4 G_{rms}.

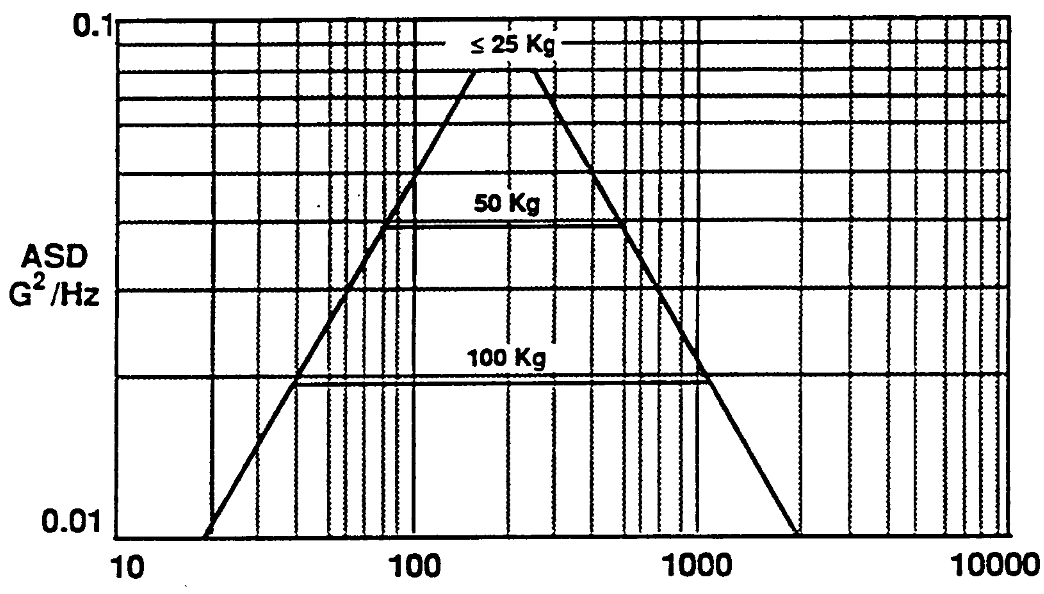


Figure 4.2.7.1.1 Random Vibration - Acceptance Levels

4.2.7.1.2 Protoqualification Level Random Vibration Testing

The test levels found in Table 4.2.7.1.2 and Figure 4.2.7.1.2 are considered a conservative estimate of the random vibration environment on a representative spacecraft bus. The test levels shown in Table 4.2.7.1.2 are the minimum test levels recommended for protoqualification.

SRDX4.2.7.1.2-1
The protoqualification test duration shall be 2 minutes per axis.

SRDX4.2.7.1.2-2
In no case shall the acceptance test levels for the sensor or its components be less than those shown in Table 4.2.7.1.2.

Table 4.2.7.1.2 Random Vibration - Protoqualification Levels

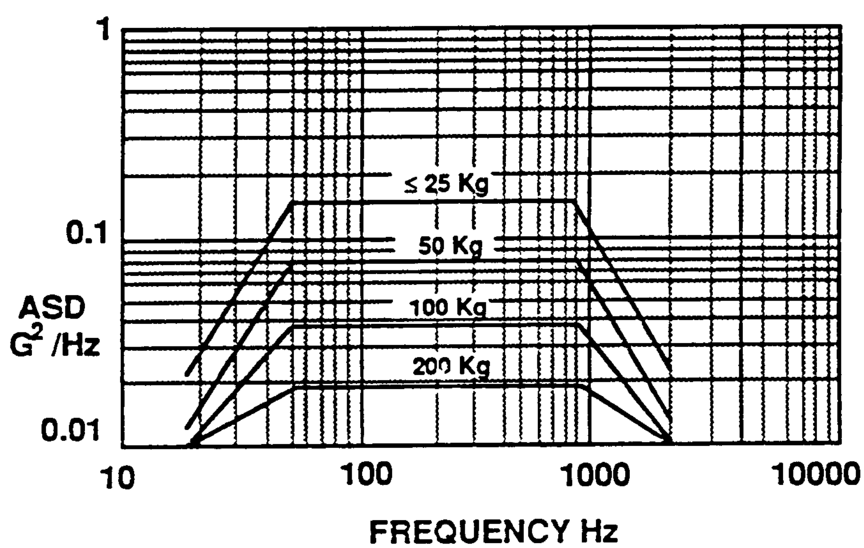
Frequency	Acceleration Spectral Density (G^2/Hz)
20	0.026
20 to 50	+6 dB/oct
50 to 800	0.16
800 to 2000	-6 dB/oct
2000	0.026
Overall	14.1 Grms

The acceleration spectral density (ASD) level may be reduced for components more than 25 kg according to:
dB reduction = 10 LOG(W/25)
ASD(25 to 400) = 0.16 x (25/W)
where W = component mass in kg

SRDX4.2.7.1.2-3
The slope shall be maintained at ± 6 dB/Oct for components up to 65 kg.

SRDX4.2.7.1.2-4
Above 65 kg, the slopes shall be adjusted to maintain an ASD level of 0.01 G2/Hz at 20 and 200 Hz.

SRDX4.2.7.1.2-5
For components over 200 kg, the test specification shall be maintained at the level for 200 kg



FREQUENCY, HZ

Figure 4.2.7.1.2 Random Vibration - Protoqualification Levels

4.2.7.2 Sine Vibration Testing

SRDX4.2.7.2-1
This test shall be conducted with the sensor suite in the launch configuration.

SRDX4.2.7.2-2
There shall be one sweep from 5 Hz to 50 Hz for each axis.

4.2.7.2.1 Acceptance Level Sine Vibration Testing

SRDX4.2.7.2.1-1
The sensor shall be acceptance tested to the sine vibration test levels specified in Table 4.2.7.2.2 and in Figure 4.2.7.2.2 in each of three orthogonal axes.

SRDX4.2.7.2.1-2
The acceptance test sweep rate shall be 4 oct/min except in the frequency range of 25-35 Hz, where the sweep rate shall be 1.5 oct/min.

4.2.7.2.2 Protoqualification Level Sine Vibration Testing

SRDX4.2.7.2.2-1
For protoqual testing, the sine vibration levels shall be the same as the acceptance test levels specified in Table 4.2.7.2.2 in each of three orthogonal axes, however the sweep rates shall be reduced by a factor of two to 2 oct/min and 0.75 oct/min respectively.

Table 4.2.7.2.2 Sinusoidal Test Levels

Frequency	Amplitude/Acceleration
5 to 18 Hz	Displacement = 12 mm (double amplitude)
18 to 50 Hz	8G peak

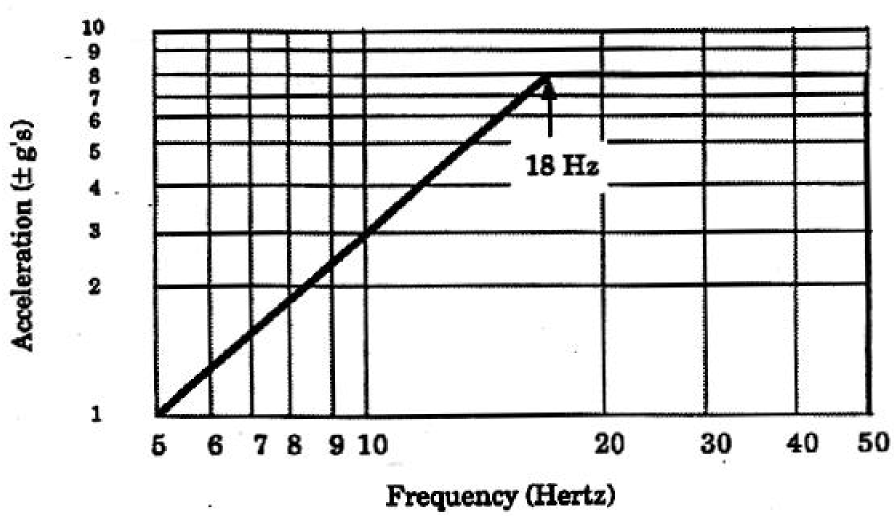


Figure 4.2.7.2.2 Sinusoidal Protoqualification Test Levels

4.2.7.2.3 Design Strength

SRDX4.2.7.2.3-1
The sensor contractor shall test the sensor structure in accordance with MIL-STD-1540C (TBR).

4.2.7.3 Acceleration Testing

SRDX4.2.7.3-1
Sensor flight hardware shall be designed to withstand a maximum acceleration of 0.015g on orbit without permanent degradation of performance.

4.2.7.4 Shock Testing

SRDX4.2.7.4-1
Sensors shall be designed and tested to survive, without permanent performance degradation, the environment shown in Figure 4.2.7.4 to account for externally induced shocks.

SRDX4.2.7.4-2
Shock testing is required at the sensor level if there are any self induced shocks (i.e., launch lock releases, pin pullers, etc.).

4.2.7.4.2 Protoqualification Level Sensor Shock Testing

SRDX4.2.7.4.2-1
Protoqualification testing is accomplished by actuating the device two times for each self-induced shock source to account for the scatter associated with the actuation of the same device.

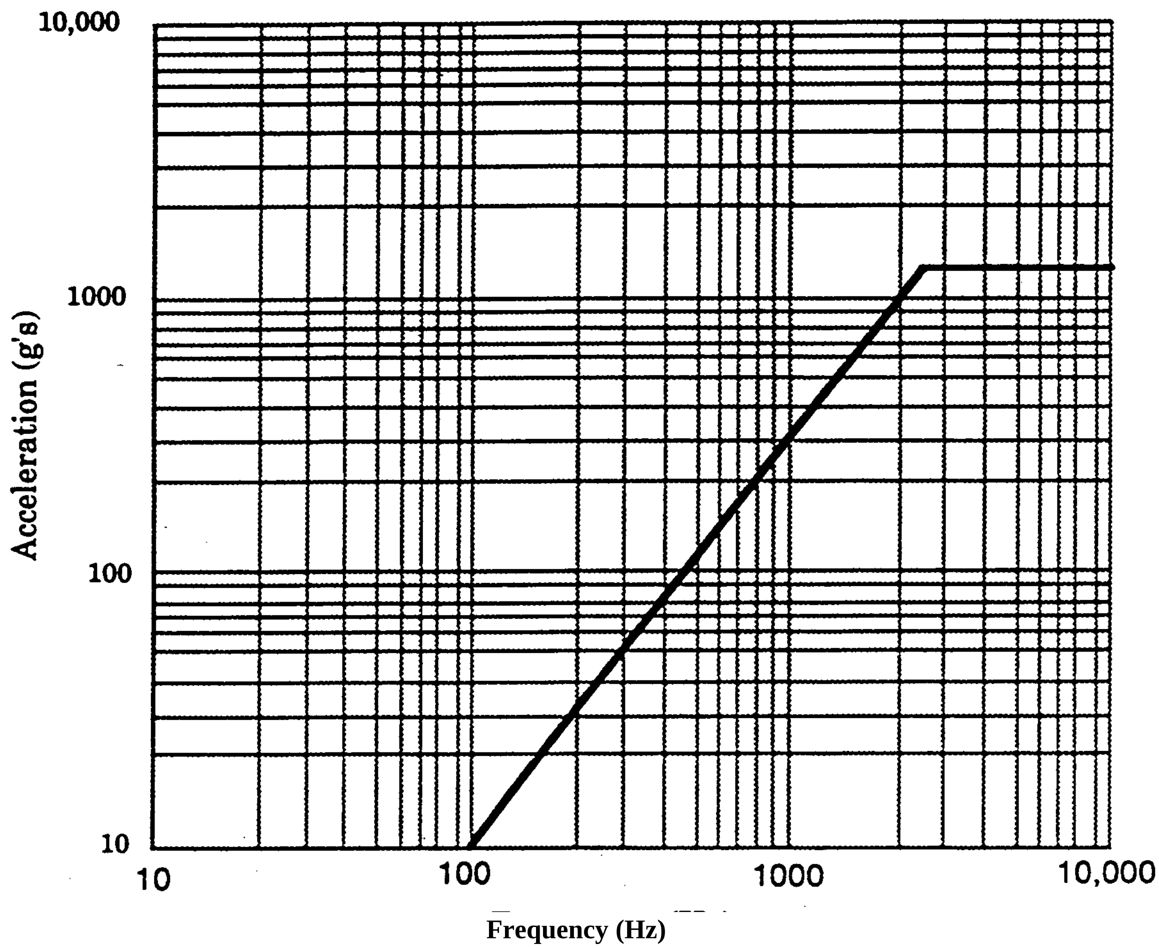


Figure 4.2.7.4 Shock Spectrum (Q=10)

4.2.7.5 Acoustic Testing

SRDX4.2.7.5-1
Acoustic testing shall be performed for sensors with large surfaces (units with surface to mass ratio greater than 150 cm^2/kg (50 in^2/lb)), which could be excited by the acoustic field directly. For sensors less than 180 kg, vibration testing may be substituted for acoustic testing.

SRDX4.2.7.5-2
Acoustic testing shall be performed in accordance with MIL-STD-1540C (TBR).

4.2.7.5.1 Acceptance Level Acoustic Testing

SRDX4.2.7.5.1-1
The acceptance test acoustics levels shall be as defined in Table 4.2.7.5.1.

SRDX4.2.7.5.1-2
The acceptance test duration shall be one minute.

Table 4.2.7.5.1 Acceptance Acoustics Levels

One-Third Octave Center Frequency (Hz)	Noise Level (dB) ref: 0 dB = 20æPa
25	118
32	123
40	127
50	130
63	132
80	133
100	133.5
125	134
160	134
200	134
250	134.5
315	135.5
400	135.5
500	133
630	128.5
800	127
1000	124
1250	122
1600	120
2000	119
2500	118
3150	116.5
4000	115.5
5000	114.5
6300	114
8000	113
10000	112
Overall	145dB

4.2.7.5.2 Protoqualification Level Acoustic Testing

SRDX4.2.7.5.2-1
The protoqualification test levels shall be the levels shown in Table 4.2.7.5.1 increased by 3 dB.

SRDX4.2.7.5.2-2
The protoqualification test duration shall be two minutes.

4.2.7.6 Thermal Testing

SRDX.4.2.7.6-1
Thermal vacuum testing shall be performed in accordance with MIL-STD-1540C (TBR) using the environmental temperature ranges specified in SRD Paragraph 3.2.4.

SRDX4.2.7.6-2
Thermal cycle testing shall be performed in accordance with MIL-STD-1540C (TBR) using the environmental temperature ranges specified in SRD Paragraph 3.2.4.

SRDX4.2.7.6-3
Thermal balance testing shall be performed on the fist production unit in accordance with MIL-STD-1540C (TBR) using the environmental temperature ranges specified in SRD Paragraph 3.2.4.

SRDX4.2.7.6-4
An assessment on the need for Solar Simulation testing shall be accomplished and the result presented to the government for concurrence. .

4.2.8 EMC/EMI Testing

SRDX4.2.8-1
Electromagnetic verification testing shall be conducted in accordance with MIL-STD-462D (TBR).

SRDX4.2.8-2
The standard interface shall undergo the following EMI/EMC tests:

1. Conducted susceptibility using CS101 (30 Hz to 100 kHz), CS114 (10 kHz to 400 MHz).
2. Radiated susceptibility using RS103 (20 kHz to 10 MHz).
3. Conducted emissions using CE101 (30 Hz to 20 kHz) and CE102 (20 kHz to 1 MHz).
4. Radiated emissions using RE102 (20 Hz to 10 Mhz).

SRDX4.2.8-3
The contractor shall perform electromagnetic testing to verify that the interface will operate properly if subjected to conducted or radiated emissions from maximum expected external sources, and to verify that the design of the interface does not result in deleterious conducted or radiated signals that might affect other mission elements. Sensors that fail to meet all MIL-STD-461D requirements may be suitable for flight if detailed analysis and system-level EMI/EMC testing shows no impact on mission operations.

SRDX4.2.8-4
The contractor shall perform conduction and radiation tests on the sensor, operating with expected power levels, current, and data rates.

SRDX4.2.8-5
All requirements shall be verified by test.

SRDX4.2.8-6
Sensor charging verification shall be conducted in accordance with MIL-STD-1541A except paragraph 6.5.2.4.1.

SRDX4.2.8-7
The contractor shall verify that his sensor does not impact the Search and Rescue mission during any mode.

4.2.9 Current Margin Testing

SRDX4.2.9-1
Electrical current margins on all electro-explosive ordnance circuits shall be demonstrated by a test. The test will verify that no less than the minimum recommended firing current (twice all-fire) will be delivered to the electro-explosive devices under worst conditions of minimum voltage and maximum circuit and electro-explosive device resistance.

SRDX4.2.9-2
The test shall verify that the maximum current delivered to the electro-explosive device does not exceed its maximum qualified firing current under worst conditions of maximum voltage and minimum circuit and electro-explosive device resistance.

4.2.10 Deployment Testing

SRDX4.2.10-1
The deployment and latching devices shall be tested to demonstrate adequate functioning under worst case environments in accordance with MIL-A-83577B, Assemblies, Moving Mechanical for Space/Launch Vehicles (TBR).

4.2.11 Outgassing

SRDX4.2.11-1
Outgassing evaluation tests shall be conducted for materials, components, and sub systems whose properties are not known.

4.2.12 Requalification of Existing Designs.

SRDX4.2.12-1
Items that incorporate extensive changes in design, manufacturing processing, environmental levels, or performance requirements shall be requalified. However, methodology from MIL-HDBK-340 may be used to show that existing designs or items (previously qualified for other applications) have adequately demonstrated compliance to all qualification requirements for the new designs. Deficiencies in meeting some requirements may be fulfilled by supplementing existing data with new test data.

SRDX4.2.12-2
Qualification by similarity shall be permitted only with the concurrence of the contracting officer.

SRDX4.2.12-3
Waiver of qualification or requalification requirements shall be approved by the contracting officer.

4.2.13 Lifetime Testing

SRDX4.2.13-1
Life time testing shall be conducted in accordance with MIL-STD-1540C (TBR).

SRDX4.2.13-2
Explosive ordnance devices and other components whose performance may degrade with time shall have life extensions based upon passing either an aging surveillance test or an accelerated aging test.

4.2.14 Pre-launch Validation Tests.

To the extent practicable, pre-launch sensor-level inspections and tests will be conducted to verify by end-to-end testing that each critical path in the launch system, spacecraft, and sensor is satisfactory. Whether electrical, mechanical, or both, all critical paths or circuits will be verified from the application of the initiating signal through completion of each event. This testing verifies:

- That an event command or signal was generated properly and sent on time;
- That it arrived at its correct destination; that no other function was performed; and
- That the signal was present other than when not programmed.

Once successfully accomplished, that particular critical path or circuit is considered validated. Not all end-to-end tests can be performed with only flight hardware, as in the case in which an explosive event is involved. In cases in which end-to-end testing cannot be performed with the flight hardware and software, appropriate simulation devices will exercise the flight hardware and software to the maximum extent possible. Simulation devices will be controlled carefully and will be permitted only when there is no feasible alternative for conducting the test. All of the events that occur during the mission profile should be tested in the flight sequence to the extent that is practical. Redundant components and subsystems also should be validated in the same manner.

4.2.14.1 Sensor Pre-launch Validation Tests.

SRDX4.2.14.1-1
Pre-launch validation tests shall be conducted on sensor equipment in accordance with the applicable requirements of MIL-STD-1540C (TBR).

4.3 VERIFICATION

4.3.1 Standard Scenes

The government will use standard datasets and sensor performance models to test the performance of contractor sensor designs and algorithms, as well as supply standard datasets to contractors for their use in developing designs which meet the TRD requirements. For all sensors, the government will develop a set of up to 10 (TBR) standard datasets in each of the climate categories relevant to the sensor and its allocated EDRs. Up to half of these will be available to the contractors for design development. The remainder will be retained by the government to evaluate designs which are delivered at PDR. The sensor-specific details of the types and characteristics of the standard datasets are provided in the SRD (see paragraph 3.2.1).

SRDX4.3.1-1
The contractor shall provide to the government sufficient design-specific information and science algorithms to allow the government to accurately model the performance of the design, including (TBR) parameters for each sensor.

4.3.2 Verification Methods

SRDX4.3.2-1
Methods of verification shall be selected from the following:

a. Inspection. An observation or examination of the item against the applicable documentation to conform compliance with requirements.

b. Analysis. A process used in place of or in addition to testing to verify compliance with specifications. The techniques typically include an interpretation or interpolation or extrapolation of analytical or empirical data under defined conditions or reasoning to show theoretical compliance with stated requirements.

c. Demonstration. An exhibition of the operability or supportability of an item under intended service-use conditions. These verifications are usually non-repetitive and are oriented almost exclusively toward acquisition of qualitative data. Demonstrations may be accomplished by computer simulation.

d. Test. An action that verifies an item's operability, supportability, performance capability or other specified qualities when subjected to controlled conditions that are real or simulated. These verifications may require use of special test equipment and sensor to obtain quantitative data for analysis as well as qualitative data derived from displays and indicators inherent in the item(s) for monitor and control.

e. Similarity. Similarity is the process of comparing a current item with a previous item, taking into consideration configuration, test data, application and/or environment. The evaluation shall be documented and shall include: the test procedures/reports of the item to which similarity is claimed; a description of the difference(s) between the items; and the rationale for verification by similarity.
All in orbit experience shall be documented and available for review.

f. Not Applicable. Use of the term "Not Applicable" shall be limited to those paragraph/paragraph headings for which there is no method of verification or where verification is accomplished in subparagraphs.

4.3.3 Requirements Validation

SRDX4.3.3-1
EDR requirements shall be validated by the contractor by analysis, modeling, and/or simulation based on the instrument design and performance characteristics and the contractor's scientific algorithms. The standard scenes provided by the government may be used for this purpose, but need not be relied upon exclusively by the contractor.

SRDX4.3.3-2
All relevant sources of error, including those associated with the scene radiance, instrument, spacecraft, data transmission, and algorithms, shall be taken into account. The spacecraft contractor is to provide errors associated with spacecraft and data transmission.

SRDX4.3.3-3
The contractor's analysis, modeling, and/or simulation shall be sufficiently extensive in scope to verify that EDR requirements are met under a broad range of conditions (TBR) that are representative of those occurring in nature, including both typical and extreme conditions. EDR requirements should be validated for any value of the geophysical parameter within the specified measurement range, any latitude, any time of day (subject to specified daytime or nighttime only restrictions), any season, any climate, any level of cloudiness (subject to specified clear/cloudy restrictions), any sensor viewing geometry, and any degree of horizontal or vertical spatial structure in the observed scene consistent with nature. The contractor is not relieved from this requirement by any limitations in the standard scenes provided by the government (See Section 3.2.1.34.) This requirement may be satisfied by a judicious choice of typical and stressing test cases for analysis, modeling, and/or simulation, and should not be construed to entail exhaustive validation throughout the space of parameters and conditions mentioned in this paragraph.

SRDX4.3.3-4
For simulations involving random variate generation, a sufficient number of iterations shall be performed for each test case or standard scene to ensure that statistical errors are negligible compared to the EDR attribute value being validated.

4.3.4 Data Bases

SRDX4.3.4-1
The contractor shall include in his requirements flowdown analysis uncertainties in data from any data bases that are relied upon in generating EDRs.

SRDX4.3.4-2
The contractor shall notify the government

1) If the contractor determines that these uncertainties prevent a threshold requirement from being met;
2) If reliance on the data base is deemed necessary by the contractor; and
3) If the data base varies in time, (that is, is updated in near-real-time), and is not under the control of the contractor.

The government will determine the appropriate remedial action.

SRDX4.3.4-3
The contractor shall generate a new data base or partial data base if a fixed data base, (e.g., one addressing terrain) is needed, and existing data bases are not adequate to allow meeting EDR thresholds. The IDPS (TSPR) contractor will be responsible for developing any new fixed data bases needed by the operational algorithms.

SRDX4.3.4-4
The contractor shall identify and quantify any EDR performance degradation resulting from the lack of availability of any data base or other ancillary data.

4.3.5 External/Built-in Testing

SRDX4.3.5-1
The sensor shall have the capability of being externally tested, while in storage and on the launch pad, to verity its performance and operational readiness.

SRDX4.3.5-2
Each sensor shall have the capability to perform self-testing using built-in test (BIT) functions to determine its functionality, performance, and operational readiness, both on the ground and on-orbit.

4.3.6 Burn-in

TBD

5. PREPARATION FOR DELIVERY

5.1 PRESERVATION AND PACKAGING

SRDX5.1-1
The contractor shall pack and handle deliverable items so as to protect them against vibrations, shocks, moisture, and contamination associated with ground or air transport.

SRDX5.1-2
The contractor shall provide protection against natural environmental conditions using containers, shrouds, or covers.

SRDX5.1-3
The contractor shall provide access provisions for inspection and handling for all deliverable items.

SRDX5.1-4
All deliverable items shall include positive means to verify compliance with shock, temperature, and moisture requirements.

5.2 MARKINGS

The contractor should mark deliverable units in accordance with MIL-STD-129K as appropriate for the item being prepared.

SRDX5.2-1
Nameplates for hardware shall contain the item or configuration item number, serial number, lot number (or contract number), manufacturer, and nomenclature.

SRDX5.2-2
Software media shall be marked to display software configuration item number, serial number, contract number, manufacturer, and nomenclature.